FINAL REPORT

IMPROVING THE NUTRITIVE VALUE OF WHEAT FOODS

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CONTRACTOR

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IMPROVING THE NUTRITIVE VALUE OF WHEAT FOODS

SUMMARY

The developing countries of the World were reviewed for their potential for protein fortification of wheat foods. Eight countries were assessed by on site visits: Bolivia, Chile, Costa Rica, Equador, Egypt, Morocco, Paraguay, and Sri Lanka. Attempts to initiate protein fortification projects in Morocco, Costa Rica and Sri Lanka were unsuccessful. A joint project was consummated with the Ministry of Industry and Commerce in Bolivia considering fortification with soy, vitamins and minerals and extension of wheat flour with quinoa, rice and corn. Project studies or activities included: laboratory baking tests, commercial baking tests, a demonstration composite flour mill, consumer acceptance tests of fortified bread rolls and pasta, physiological acceptance test of fortified bread rolls, and the determination of the requirements for refitting an oilseeds solvent extraction plant to produce food grade defatted soy flour. A three phase implementation plan was recommended: I) Immediate addition of 10-25% partially gelatinized low fat corn flour in all pastas (18% of all wheat in use in Bolivia), II) After modification of the soy processing plant (approximately one year), fortification of all pastas with 5% defatted soy flour, III) Upon reaching full production of defatted soy flour and upon installation of feeders and blenders in Bolivia's 17 wheat mills, fortification of all wheat flour with 5% defatted soy flour at the wheat mills. The program promises to increase daily per capita protein intake by 2.3 grams, reduce wheat imports by $US 5,700,000 annually and stimulate Bolivian agriculture and agribusiness.

IMPROVING THE NUTRITIVE VALUE OF WHEAT FOODS

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PROJECT OBJECTIVES

I. "Implementation of new fortification technologies in Less Developed Countries (LDC's) through the introduction of low cost nutritionally improved wheat-based foods.

II. Accelerate the utilization of new wheat fortification technologies through dissemination of information and demonstration of their utility for nutrition intervention programs."

While "new fortification technologies" mentioned above in the Project Objectives were not delineated, the Agency for International Development (AID) primarily had in mind the series of technologies and research developments demonstrating the successful addition of protein additives (and wheat extenders---composite flour) to various wheat products. Of special interest was the addition of defatted soy flour to bread flour and the maintenance of good bread quality through use of surfactants and other bread improvers in the baking process. AID has been a prime mover in this area through support of research at Kansas State University and other institutions and through distribution of the highly successful soy-fortified bread wheat flours under the Food for Peace Program. Included as part of the "technology" is the reservoir of recent knowledge on the production of suitable protein additives; for example, flash desolventizing of defatted soy flour to control protein dispersibility and achieve lighter color; or, the preparation of full-fat soy flour by extrusion cooking.

CONTRACT SCOPE OF WORK

The PASA Scope of Work visualized the introduction of protein fortified wheat foods over three years into two LDC's having a malnourished population or population group. In selecting suitable countries, it called on the contractors to consult available literature and appropriate authorities and to make evaluation visits to promising countries.

Once a suitable country was identified, the following sequence of events were proposed:

- Select a wheat food to be fortified.
- Demonstrate the fortified product in the LDC.
- Contract a food intake survey of the target population so as to be able to assess the "nutritional impact" of the fortification program.
- Arrange for establishment of pilot production.
- Contract consumer acceptance studies.
- Promote and assist establishment of commercial production capacity.
- Contract nutrition education and product advertising.
- Repeat food intake survey to assess "nutritional impact" (increased consumption of nutrients.)

Subsequently, the scope was amended to reflect early experience in performing the contract and probable future results. In particular, of the seven countries visited, only Bolivia eventually yielded a project and so the PASA contract was amended to recognize this. Because the Bolivian effort was to be a National effort of great magnitude, three phases were visualized: Research and Development; Feasibility; and Implementation. The PASA was expected to assist through these phases as far as to the completion of a comprehensive plan of implementation. Because of several political disturbances in Bolivia that delayed the Project, the three year PASA Contract was extended without additional funds for an additional 1-1/2 years.

RESOURCES AND MODE OF OPERATION

A total of $US 605,000 was allocated for use under the PASA.

In order to accomplish the scope of work, the PASA team was to work through AID missions. Once a counterpart agency was identified, the PASA team, through temporary duty assignments, would assist the agency to develop the project. The PASA provided for the support of short term, U.S. consultants, contracting of services in the project country, and purchase of some equipment and supplies.

The PASA team was composed of a Food Technologist (Project Manager), Nutritionist, Agricultural Economist, Baking Technologist and two Cereal Technologists. All were assigned part time to the Project, varying from 10 to 50%.

It is obvious that additional resources were anticipated from the counterpart agency though quantitation was not possible.

ACCOMPLISHMENTS

I. Selection Process for Target Countries.

The factors of concern were as follows:

1. Wheat availability per capita; not less than 30 Kg/year.
2. Gross National Product per capita; maximum $US 762 (1974).
3. Importation of wheat; minimum 45%.
4. Nutritional indicators of protein deficiency in the target population.
5. Local protein resources availability for use in fortification.
6. Presence of a country Food and Nutrition Policy.
7. Friendly reception and stable government.
8. Presence of an AID Mission and willingness to assist.

A sufficiently high consumption of wheat products is essential if fortification is to have a significant impact. Wheat availability was used as an indicator of consumption of wheat products. Gross National Product per capita provided an indicator of need. On the other hand, too low a Gross National Product suggests lack of infrastructure and difficulty in implementing a technical project. A requirement for importation of at least 45% of the wheat was imposed so that the project would have the added benefits of import substitution and stimulation of domestic agriculture and employment (to grow and process the protein fortifiers and non-wheat extenders.)

Table 1 provides a list of countries by wheat availability per capita in 1974. Table 2, then, lists the countries whose wheat availability is at least 30 Kg per capita, whose wheat imports are at least 45% of total supply and whose Gross National Product per capita is less than $762.00.

Algeria, Belize, Malaysia and Mauritius were eliminated because of the lack of an AID Mission which is essential for administrative support in country. Jamacia, Guyana, Yemen A.R., and Peru were eliminated on the belief that our reception in those countries at that time would be less than satisfactory or possibly dangerous. The Republic of Korea was eliminated since the Nutrition and Agribusiness Group, OICD, USDA was already involved in an AID supported soy-fortified bread project in that country. Brazil was known to have studied and attempted to implement composite flours, including soy-fortified flours. It was felt that Brazil was well advanced and that PASA assistance would not be of maximum value. In addition, the AID program in Brazil was being phased down. For these reasons, Brazil was eliminated from further consideration.

Seven countries remained for more detailed study: Bolivia, Chile, Costa Rica, Egypt, Morocco, Paraguay and Sri Lanka.

II. Prefeasibility Studies of Selected Countries

Prefeasibility studies involved two aspects: (1) accumulation of information from knowledgeable people and from the literature and (2) travel by a three person team to the country of interest. Each team included a cereal technologist, a nutritionist, and an economist. Information on the seven countries is listed in Table 3.

The summary impressions of assessment visits are given below. In addition, detailed assessment reports were prepared for Costa Rica, Bolivia and Morocco. The Costa Rican assessment report is presented in Appendix A-1; the Bolivian assessment report is presented in Appendix B-1; and the Moroccan assessment report is presented in Appendix C-1. Late in the project (1980), a request to review the Ecuadorian composite flour program was accepted; Appendix D contains the Ecuadorian assessment report.

TABLE 1

Availability of Wheat Per Capita in Countries of the Free World, 1974.
Value equals production plus imports minus exports.*

Country	Wheat Kg/Capita	Country	Wheat Kg/Capita	Country	Wheat Kg/Capita
Australia	435	Norway	90	Dominican Rep	22
Cyprus	306	Trinidad & Tabago	88	Colombia	22
Turkey	291	Portugal	85	Nicaragua	20
Greece	272	Jamaica	83	Guatemala	19
Syria	262	USA	83	Nepal	18
Israel	225	Belize	82	Indonesia	17
Italy	225	Mauritius	79	Ivory Coast	16
Uruguay	214	Yemen AR	74	Angola	16
Chile	199	Singapore	68	Haiti	16
France	196	Guyana	66	El Salvador	14
Argentina	194	Bhutan	65	Cameroon	14
Tunisia	192	Figi	63	Malagasy	14
Belgium	186	Saudia Arabia	58	Honduras	14
Luxemborg	184	Peru	56	Kenya	13
Sweden	181	Martinque	56	Philippines	13
Malta	174	Japan	51	Mozambique	12
Iraq	168	Korea Rep	50	Benin	12
UK	162	Brazil	50	Sierra Leone	12
Afghanistan	160	South Africa	49	Ghana	10
Libya	159	Bolivia	49	Tanzania	10
Morocco	157	Venezuela	47	Sikkim	10
Algeria	149	India	44	Thailand	7
Austria	148	Lesotho	44	Guinea	6
Iran	146	Sri Lanka	43	Zaire	6
Lebanon	145	Costa Rica	39	Liberia	6
Germany Fed	142	Barbados	38	Togo	6
Egypt	136	Mexico	38	Nigeria	6
Guadaloupe	134	Malaysia	32	Chad	5
Jordan	130	Paraguay	31	Niger	5
Netherlands	130	Ecuador	29	Upper Volta	4
Pakistan	125	Hong Kong	28	Burma	2
Ireland	124	Senegal	28	Burundi	2
Spain	123	Zimbabwe	28	Botswana	1
Switzerland	117	Zambia	28	Namibia	1
Canada	111	Ethiopia	28	Mali	1
Finland	111	Panama	27	Uganda	1
New Zealand	104	Sudan	26	Rwanda	1
Denmark	91	Bangladesh	25	Malawi	1
Bahamas	91	Somalia	23	Central African R	0
				Papau N. Guinea	0
				Mauritania	0

*These values include use as food, feed and seed. As a World average, 1962, 6.8% of wheat was used as feed. Sources: 1974 FAO Production Year Book; 1973/74 FAO World Grain Trade Statistics; Foreign Ag. Cir. FG20-78, USDA, 1978; Foreign Ag. Ec. Rpt. 63, Growth in World Demand for Feed Grains, USDA, 1980.

TABLE 2

Candidate Countries for a Wheat Fortification Project. Minimum wheat availability of 31 Kg/Capita; minimum of of 45% wheat imported; maximum of $US 762 GNP/Capita.

Country	Wheat Availability Kg/Capita	% of Wheat Imported	$US GNP/Capita
Chile	199	54	762
Morocco	157	45	194
Algeria	149	64	405
Egypt	136	62	242
Jamaica	83	100	694
Belize	82	100	506
Mauritius	79	100	737
Yemen AR	74	93	47
Guyana	66	100	280
Peru	56	86	546
Korea Rep	50	92	277
Brazil	50	47	672
Bolivia	49	75	209
Sri Lanka	43	100	164
Costa Rica	39	100	580
Malaysia	32	100	451
Paraguay	31	68	272

Table 3. Statistical Data on Seven Candidate Countries for a Wheat Fortification Project

(Condensed from Several Project Study Documents)

Time Frame Mainly 1974-1977

Item	Bolivia	Chile	Costa Rica	Egypt	Morocco	Paraguay	Sri Lanka
Population	5,140,000	10,420,000	1,940,000	38,042,000	18,049,000	2,770,000	13,874,000
Gross National Product per capita	$209	$762	$580	$242	$194	$272	$164
Life Expectancy	47	63	69	53	53	61	66
Infant Mortality per 1000 live births	145; 154; 161	102; 55	43; 28	144; 89	130; 149	39	50; 45
Available Calories per capita	1902; 2557; 1900	2670	2344; 2600; 2610	2500	2200	2776; 2740;	2170
Intake of Calories per capita	2345	2200 (below 2000 in 37% of families)	1961	-	2466; urban 2202; rural 2600; shantytown 1809	2350	-
Consumed Calories, % of Physiol.Req.	79	109	116	100	92	119	98
% of Consumed Calories from Wheat	20	44	11	43	63	16	19
Protein, g. per capita available	46; 45.8; 51.4	77; 66.4; 10% of population gets below 40	66; 62; 61.3	69	62; 57.7	73; 65.4; 71.4	48
Deficiency Diseases, Regionally or Nationally	Goiter (I) F. Hyperkeratosis (A) Anemia (Fe) B_1 & Vit C low level in some diets	F. Hyperkeratosis (A) Angular lesions (B_2) Goiter (I) B_1 & B Complex at low levels in some diets	F. Hyperkeratosis (A) Goiter (I) Anemia (Fe, folacin) B_1 & B_2 at low levels in some diets	Anemia(Fe, B_{12}, folacin) Xerophthalmia (A) Rickets (Vit D, Ca) Pellagra (niacin) Goiter (I)	Anemia(Fe, B_{12}, folacin) Rickets (Vit D, Ca) Goiter (I) Xerophthalmia (A) Pellagra (niacin)	Anemia(Fe, B_{12}, folacin) F. Hyperkeratosis (A) Goiter (I)	Avitaminosis; general undernutrition due to periodic food shortages
Compulsory Wheat Flour Enrichment	No; 6% required quinoa addition unsuccessful	Yes; B_1, B_2, niacin, Fe, Ca optional	Yes; B_1, B_2, niacin, Fe, Ca optional	No	No	No	No
Wheat Available per capita, Kg/yr.	49	199	39	136	157	31	43
% of Wheat Imported	75	54	100	62	45	68	100
Protein resources available per capita, Kg/yr.	soy 1.9, peanut 1.9 pulses 2.5	soy 0.1, fishmeal 19.2 pulses 13.9	soy 0.5, coconut 4.1 pulses 5.2	soy trace, peanut 0.8 sesame 0.8, pulses 9.1 (10% import)	soy 0.9 (all import) peanut 0.7 fishmeal 1.2 pulses 29.3 (35% export)	soy 78.8 (largely exported); peanut 4.7; pulses 15.2	soy trace; peanut 1.4; coconut 97.3 sesame 0.5; pulses 0.6
Nutritional status, % PCM in children under age 5	29.0 slight 10.2 moderate 0.7 serious	11.5 slight 3.1 moderate 0.8 serious	41.0 slight 11.0 moderate 1.0 serious	46.0 mild to moderate 4.0 serious	under age 4 42.3 moderate to serious	4.9 slight 2.2 moderate 0.7 serious	34.7 mild to moderate 6.6 serious
Milling industry, # of mills and other information	16 mills; smallest 10MT per day, largest 300; 80% domestic wheat is autoconsumed; flour is subsidized; official extraction rate 72%.	250 mills have 95% of capacity; several hundred small mills; bread flour extraction rate is 78%	1 mill of 410 MT/day; 70-72% extraction rate; 3% of flour used at homes; 85% of imported wheat is US HRS & HRW.	226 mills; thousands of small ones; 82 plus% extraction for balady which is 2/3 of all bread; 72% extraction for European breads.	65 mills work imported & local soft wheats; flour subsidized; hundreds of artisan mills; 50% local wheat, esp. durum, is autoconsumed.	5 mills; 72-80% extraction; 5-10% of flour used at home. Homemade tortillas used	1 mill at 400 MT/day; 2nd mill planned 1980; 83% of wheat imported as flour; extraction rate 76%; flour subsidized.
Baking industry, # of plants and other information	3000 plus artisan; some semi-mechanized: 77% of all flour use; main product is marraquetas or hard rolls	1700 bakeries; marraquetas 70% of bread production	6 medium sized; 300-1500 artisan; main products are bollitos (rolls), pan & french; 78% of all flour use.	2000 plus artisan; European bread semi-mechanized; much dough made at home baked at village oven.	569, used 3.8% of all flour; most bread made at home baked at village oven; 80 plus% extraction -- dark bread.	700+ artisan bakeries; 60-65% of all flour used; much dry bread produced for shipment to rural areas.	many artisan; 50-75% of all flour used; 25-50% of all flour is used for home made flat breads; commercial is pan bread
Pasta industry, # of plants	50; no durum; 20% of all flour used.	5-10% of all flour used	1 large, several small; 15% of all flour used; 17% corn added at one plant (precooked).	Some cous cous; no durum grown; very little pasta made; 1 or 2 plants	29 pasta & cous cous plants; 0.9% of all flour used	At least 10; one adds vitamins; 25-30% of all flour used. Also made at home	-
Cracker, cake & cookie industry, # of plants	2 or 3 major plants; 3% of all flour used.	72% extraction for pastries and cakes	4% of all flour used	-	17 plants; 0.3% of all flour used.	Galletas (crackers) popular; distributed in rural areas.	at least 2 large plants

A. COSTA RICA:

The assessment trip to Costa Rica was made October 16-30, 1976. Discussions confirmed that Protein-Calorie-Malnutrition (PCM) is a serious problem in Costa Rica for weaned children (6-30 months) with those in the very sparsely populated rural communities being the most seriously affected. Several surveys have shown that calories are usually more deficient than protein in diets. Problems also exist as to the adequacy of iron, iodine, Vitamin A, and riboflavin.

The Government of Costa Rica (GOCR) was in the second year of implementing a comprehensive, well funded, integrated nutrition-public health-sanitation program (Social Development and Family Assistance Program -- Asignaciones Familiares) aimed at the most vulnerable and needy groups. As part of the program, all children in need between 0 and 12 years of age are to receive 2 free meals each day providing 80% of the caloric and 60% of the protein requirements.

In 1976, the child feeding programs reached about 25% of the potential target group using over 50% of the special employment tax revenues available. About 50 products from the commercial market are used including large quantities of dried whole milk. Reduction in number and cost of products, improved stability of products and increased use of domestic commodities are major objectives as the program expands. CITA (Food Research Center, University of Costa Rica, San Jose) has major responsibility to recommend and develop products, provide specifications, and assist industry in setting-up production capability.

Agriculture is the main source of employment (36%; 1973) and income accounting for 22% of the Gross Domestic Product in 1972. Coffee, sugar, bananas, and beef exports accounted for two-thirds of export earnings. The GOCR is aggressively pursuing increased production of rice, corn, sorghum and beans through a price support program and development of transportation, storage and marketing infrastructure. Production has increased dramatically and in the case of rice, a surplus situation was recorded in 1975. Accordingly, composite flour programs are fast becoming meaningful as a way to save foreign exchange (reduction in wheat imports.) Stimulation of the agricultural sector is improving the income of farmers and farm workers thus reducing migration to urban areas, a major objective of the government.

Annual per capita wheat disappearance is 90 lbs. (1976; all imported.) Members of the lower socio-economic groups and those living in rural areas eat less bread than those in higher socio-economic groups or those in urban areas. Bread is produced in 6 large bakeries, and rolls (bollitos) in a large number (300-1300; range of estimates) of small bakeries. Pasta consumption is generally more uniform and is on the order of 10 to 15% of all wheat consumed. Galleta, a popular sweet cracker, is a low-cost wheat product with long shelf life. It appears to have good potential for fortification and use in feeding programs. Alternatively, if it is desirable to reach a broad cross-section of the population the large bakeries produce a wide-range of products for distribution throughout the country. They have the capability of producing high-protein and/or composite flour products, given an adequate supply of high quality ingredients at an economic advantage.

Costa Rica's only flour mill is a modern one with daily capacity of 7,500 cwt. Extraction rates are low: 67% for US hard spring wheats and 71% for US western

white. Four different flour types are produced: bread, durum semolina, durum-common wheat blend and pastry. Prices are fixed by the government for full recovery of all costs. Almost all flour is packed in 100 lb cotton sacks and can be delivered to any location in the country in 24 hours. Quality is very high and is routinely monitored in a well equipped quality control laboratory. The low extraction rate results in a wheat millfeed highly suitable for recovery of wheat protein concentrate, a high protein flour recoverable by "remilling" the millfeeds. Because the millfeed is very low cost, WPC would be an economic material to consider for use in infant food or other "fortified products." Production and processing of soybeans in Costa Rica is being carried out on an experimental basis in the Tropical Pacific Region. Cost projections suggest soy flour prices substantially above wheat flour. The only major source of vegetable protein is black beans which, as whole beans, sell at wholesale for 2.28 colones per lb. compared to bread flour at 1.28 colones per lb. Black bean flour is not available.

Except for one pasta manufacturer making and using a small amount of precooked corn flour in pasta, there is no major production of corn or rice flours for use in a composite flour program.

Yuca production has increased dramatically in the last 20 years. The government and members of the yuca constituency are attempting to find means of increasing the utilization of yuca. One attempt being made is to implement extension of wheat flour with yuca flour (3 to 20%). Because yuca flour is similar in cost to wheat flour, there is little or no economic incentive to use it on a voluntary basis. One sample of yuca flour analyzed had a very high microbial load.

CITA indicated an interest in a joint project with WRRC. Development and utilization of wheat protein concentrate was of particular interest to CITA. With a food processing capability, including breads and pastas, and with its responsibility for product improvement and development for the Asignaciones Familiares Program, CITA would be an excellent counterpart agency for the WRRC project.

B. Bolivia. The assessment trip to Bolivia was made February 19-28, 1977. The 1976 census, the first since 1950, showed the population of Bolivia to be about 4.7 million, some 16% less than estimated earlier. As a result, most previous per capita data have been thrown into a state of confusion and are probably generally understated. The population is about 70% rural and 30% urban. Some 42% live on the 13,000 foot expansive valley called the Altiplano; 35% live in smaller valleys at 6,000 to 9,000 feet elevation, an area called the Valles; 23% live in the Eastern lowlands called the Oriente or in the steep tropical valleys called Yungas.

Agriculture accounts for 65% of the employed workers. It produced exports of $US 48 million in 1972, mainly cattle, meat, coffee, cacao, timber, cotton, sugar cane, wool and rice. Major domestic crops are potatoes, corn, vegetables, sugarcane, rice, yuca, cotton and wheat.

A sound basis exists for planning and developing nutrition programs. This includes a Government of Bolivia (GOB) Five Year (1976-1980) Food and Nutrition Plan, a well defined infrastructure within the GOB for planning national nutrition strategy, and close cooperation between the GOB and USAID/Bolivia in the development of USAID nutrition strategy. USAID has recently completed health, nutrition and agriculture assessments. Based on several consumption studies, average daily per capita consumption was 1,870-1,998 calories and 44-57.5 grams protein. Adjustment for the 1976 population census suggests average availabilities of 2,200 calories and 59 grams of protein. Low income groups consume substantially less than the averages. Valles inhabitants generally consumed more calories and protein than those on the Altiplano.

The public health status is relatively poor. Infant mortality estimates range from 145 to 250 per 1,000 live births. A study of the cities of La Paz and Viacha showed 41 to 47% of under age 5 deaths were cases in which malnutrition and immaturity were underlying or associated causes. PCM among children, and anemia in pregnant and lactating women are seen as primary nutritional problems, followed by iodine (goiter) and vitamin deficiencies. PCM appears to be more prevalent on the Altiplano than in the tropical regions. The GOB defined target groups for nutritional intervention programs are those in rural areas, those less than 5 years of age, pregnant and lactating women, school children 5 to 15 years old and marginal urban poor, in that order of priority.

Per capita availability of wheat is about 110 pounds per year. Between 200,000 and 230,000 MT of wheat or wheat equivalents is imported by the GOB each year while 69,000 MT is produced domestically. About half the imports are as flour. Only 10,000 MT of domestic wheat is milled in the 12 commercial mills. The GOB intends to phase out flour imports by January 1, 1978. Accordingly, milling capacity is currently expanding rapidly. Bread rolls (marraquetas), made in small shops by hand, is the major wheat product followed by pasta (20% of total flour use.) Flour, (72% extraction) and bread prices are fixed by the GOB at the subsidized price of $US 15/100 lbs. and $.025 for a 60 gram piece respectively.

There is some composite flour experience in Bolivia including the incorporation, by National Decree, of 5% quinoa flour in wheat flour, though at present implementation is sporadic and limited to the Oruro area on the Altiplano.

Availability and cost of quinoa limit its expansion to other market areas. The outer layers of quinoa have bitter saponins and lack of objective analytical methods to detect the saponins have impeded the development of methods for milling quinoa. Soybeans, corn and rice offer new sources for protein fortified or other composite flours in the near term. Modern soy crushing capacity is installed at Sociedad Aceitera del Oriente at Santa Cruz and at the GOB's Villamontes location. In both cases, the meal produced is of animal grade. An adequate supply of soybeans is also a major problem of this fledgling industry. Rice is now in surplus and the crop is expanding. The government agency, ENA, has spearheaded the development of strong rice production, drying, processing, storage and marketing infrastructure. Rice flour production capacity is not available, but rice flour might be produced at the wheat mills. Price is likely to be the major constraint to rice utilization in composite flours. Commercial corn flour processing capacity is very limited and the general marketing structure for corn and corn products is quite rudimentary. A major advantage with corn is its generally lower cost though the price fluctuates greatly from harvest time to non-harvest time.

The Santa Cruz Public Works Development Corporation has contracted research (Contec, Inc.) that showed the technical feasibility of blending soy, corn and rice flours with wheat flour. This corporation was considering building a corn flour manufacturing plant. The Agency of Standards and Technology, Ministry of Industry, has proposed a composite flour development project and is equipping a laboratory to carry out composite flour research and to provide better quality control and regulation in the cereal area in general. The Ministry of Agriculture with the support of the Consortium for International Development is carrying out economic analyses on composite flours; soy and rice currently, corn later. Both the Ministry of Industry and the Ministry of Agriculture were interested in a cooperative composite flour project with WRRC.

C. PARAGUAY:

The assessment trip to Paraguay was made March 1-8, 1977. Per capita average consumptions are 2,492 calories and 64.4 grams protein. About half the protein is animal. These are very favorable figures compared to the recommended levels of 2,300 calories and 54 grams of protein. While the average consumption values are good, insufficient data is available to determine accurately the number or percent of people who fall below recommended levels. Fourteen critical areas have been identified in the November 1976 Food and Nutrition Plan (proposed). Two of these critical areas are barrios in the Asuncion area. The Food and Nutrition Plan is based primarily on the 1965 ICNND study. The major deficiencies in Paraguay are Vitamin A, riboflavin, calcium and iron for expectant mothers. Government policy for attacking these problems appears to be three fold: (a) Nutrition education to encourage increased consumption of foods rich in those nutrients, (b) Enrichment, (c) Parasite control through improved sanitation, water supply and education. Concern for PCM is noticably lacking.

Wheat disappearance in Paraguay is on the order of 150,000 - 160,000 MT per year. Domestic production is 30,000 MT. 1976 yield was about 1 MT per hectare.

The soft spring wheat is grown during the winter but unpredictable weather plays havoc with crop success. It is highly desirable to grow wheat because it is one of only a few crops that can be grown during winter months with a second crop of soybeans in the summer. The domestic wheat runs about 11% protein but the gluten is weak and generally poor quality for bread. The Ministry of Agriculture seeks to double wheat acreage over the next five years and improve yields with new varieties and use of fungicides.

Recent wheat imports are mainly from Argentina under concessional arrangements. Though this has resulted in shipment of some of the poorest quality Argentine wheat, it is still better quality than the domestic wheat for bread. A 30:70 blend of domestic: imported wheat is milled at up to 80% extraction (official extraction rate is 72%) yielding flour of about 0.6% ash. The import price of wheat is higher than that paid by Argentine millers thus leading to contraband flour entering Paraguay in competition with local millers. The GOP fixes the maximum price of flour and some other wheat foods and as of March 1977, wheat foods were among the lowest cost processed foods available. This would appear to be counter to the GOP policy of wheat substitution but the reality of Argentina and low flour prices next door probably makes higher wheat product prices unenforceable.

Consistent with the GOP interest in wheat substitution, there is a "Commission" on composite flour appointed by the Interministerial Economic Council that includes GOP, industry and academic representation. The Commission has made a number of recommendations of things to add to wheat flour over the last 10 years. The first was manioc (cassava) flour at 5% which failed 3 months later because of the poor quality of manioc flour. Sorghum and rice programs followed. Based on discussions with rice millers, it appears that some rice brokens are being sold to wheat millers presumably for composite flours. Most recently, the Commission has met twice to consider 10% precooked, dehulled, degermed corn flour in wheat flour. A 10,000-15,000 MT per year precooked corn flour plant is being built using Italian equipment as a joint project of the wheat miller El Molino Harinera del Paraguay and a pasta producer. Only minimal technical studies on composite flours have been carried out, some at the National Institute

of Technology and Standards (INTN). INTN also gives a baking course 3 or 4 times a year with technical assistance from Brazil. This Institute expressed an interest in cooperating with WRRC on composite flours. The production of soybeans is rising rapidly in Paraguay and may reach 400,000 MT in the current 1977 harvest year. CAPSA Corporation is a large oilseed processor with 4 Anderson Expellers of 70 MT/day capacity each. This company might be interested in producing food-grade, low-fat soy flour if the demand were over 5,000 MT per year. The process would likely be: drying, dehulling, expeller pressing, toasting and grinding. Altogether, this company processes 120,000 MT cotton seed, 60,000 MT soybeans and substantial quantities of tung, castor and peanuts. Unsuccessful efforts in Paraguay to use soy as a meat substitute several years ago left a substantial prejudice against soy in human food.

D. CHILE:

The assessment trip to Chile was made March 6-9, 1977 by Dr. Fred Barrett, Nutrition and Agribusiness Group, OICD, USDA on behalf of the WRRC project. Effort was concentrated on discussion of food and nutrition programs and plans.

Drs. Monckeberg and Yanez of the National Committee for Food and Nutrition (CONPAN) said that the Government of Chile (GOC) has very comprehensive nutrition plans that cover the entire country including 100% of infants 0 to 2 years and 2 to 6 years with milk, weaning food or milk substitute. The school lunch program includes milk, fortified cheese snacks, caramels, fortified cookies and other items that provide 30% of both calorie and protein requirements. They noted that 53% of calories of low income people come from wheat products but that protein fortificants, especially soy, would raise the price of wheat foods which is unacceptable. The approach is to consider soy and other "low cost" protein sources for use in milk and meat substitutes. Work on this approach is being done at the Technology Institute of Chile (INTEC), especially extrusion research.

Composite flour research has been completed at INTEC including soy and chickpeas for breads and pastas but has not been adopted. No food-grade soy flour is processed in country though the sugar refining company, CRAV, is planning food-grade soy flour production for use in the GOC infant food, Fortesan. CRAV see no potential for commercial introduction of soy fortified wheat foods. Of major interest for composite flour is the surplus of potatoes. A potato flour manufacturing plant is nearing completion and 6 to 8% potato flour is being researched and considered for addition to wheat flour. Fundacion, a joint Chile-ITT effort, has studied the use of lupine and crill to fortify wheat products and have developed a lupine cookie. Wheat-oat products are also being studied and an oat cookie has been developed.

Conclusions from these discussions are: (1) Calories are as important to target groups as protein; (2) The target groups of infants, children, mothers and observable malnourished are being reached by specific nutrition intervention programs; (3) Soy is not domestically available and imported soy is too expensive as a protein fortificant for wheat foods; (4) Availability and economic considerations suggest the potential of potato flour as a wheat flour extender.

There appears little need or opportunity for development of new fortified wheat foods in Chile for either the commercial markets or government sponsored programs. Under these conditions, Chile was discontinued as a candidate country for a wheat fortification project.

E. SRI LANKA:

The assessment trip to Sri Lanka was made April 17-24, 1977. This nation of nearly 14 million inhabitants has a socialist government that dominates or controls agricultural production, imports, processing, distribution and prices. While the agricultural products tea and rubber are the major export earners, Sri Lanka is a food deficit nation and must import large amounts of cereals and other foods to feed its people. Rice is the staple and, while grown on over a million acres, additional rice is imported. Wheat imports first began in 1953. In 1976, the Government of Sri Lanka (GOSL) imported 137,000 MT wheat, mostly from Australia, and 540,000 MT wheat flour from the US, Singapore and others. Wheat flour availability is 43.2 Kg per capita and supplies about 20% of the total dietary energy. All wheat is milled to about 76% extraction at the one 400 MT per day mill located at Colombo which distributes flour to most parts of the country, but not more than 50% of the supply of any district. Some bran is sold to livestock feeders but most is exported at an excellent price. Both flour and bread are subsidized which has been pushing up consumption and precipitating debate on the correctness of the wheat flour subsidy policy. Enrichment or fortification of flour at the one mill would be mechanically quite simple. Up to 10% sorghum may be legally added to and co-milled with wheat. About 30 MT of white sorghum has been so utilized, but generally sorghum has just not been sufficiently available. A second large mill is being planned. (Note: This 2,200 MT/24 hour mill was completed at Tricomalee in 1980.)

The major product of the artisan baking industry is a rather lean formula, dense pan bread. The straight dough procedure predominates. Yeast is imported from Australia or Holland. About half the flour in Sri Lanka is used at home where flatbreads and "hoppers" (steamed small round pieces) are made. There appears to be a very strong positive prejudice toward white breads in general. Consumption surveys have shown that all socioeconomic groups consume wheat products. Children begin receiving bread as early as 6 months.

Composite flour research has been carried out at CISIR, with assistance from the Tropical Products Institute of the UK, on cassava, full fat soy, millet, sorghum and maize at levels to 10% substitution and utilizing potassium bromate but not fatty dough conditioners. The one application has been the allowance of the addition of 10% sorghum to wheat for co-milling.

The 1973 world grain shortages and high prices coupled with Sri Lankan import restrictions on pulses led to a dramatic increase in pulses acreage (125,000 acres) in Sri Lanka. Further increases are likely as supply is not meeting demand. This may be possible, for example, by intercropping with sugarcane or planting rice paddies during the dry season. While land is scarce, it is estimated that only half is planted for a second crop within the annual cycle. In the case of soybeans, INTSOY of the University of Illinois came into Sri Lanka in 1972 at which time there were a few experimental plots. The GOSL Soybean Development Program was initiated and work to date has shown good potential for soybeans with an average yield capability of 1,000-1,200 Kg/hectare, nearly twice that of pulses. While the price of soybeans has been similar to pulses, once established, they should be less expensive. The major problem in establishing soy now appears to be lack of markets. A few hundred tons are being co-extruded with maize in a Brady Crop Cooker for the Thriposha infant food program and some is being used for a coffee substitute. Fortification of locally milled

wheat flour with 10% full-fat soy flour would require about 11,000 MT of soybeans and could make soy a viable crop. With such an accomplishment, the GOSL might have more success in their efforts to develop milk and meat substitutes from soy which are of primary interest, especially for import substitution of milk.

Other potential protein sources for a fortification program are coconut and rice bran. The very large coconut production has declined since the breakup of the large estates, and where previously exported, copra supply is now insufficient to meet domestic demand. Some coconut residue-rice bran mixture is marketed as feed but there is no work on recovery of food protein from coconut residue. About 8% of rice is parboiled in Sri Lanka. Bran from white rice is not stabilized. The GOSL Paddy Marketing Board is expecting to set up an oil recovery scheme in Polonnaruwa district that would require bran stabilization and this could be a first step toward producing a food-grade product from rice bran. A substantial portion of rice is undermilled (4% bran removal) and the consumer purchasing this usually has it remilled by local village millers to give the standard white rice with 8% bran removal.

Nutritional aspects are considered at the highest levels in government through the National Nutrition Committee composed of the heads of several ministries. A Food and Nutrition Policy Planning Work Group assists the Committee. Information on nutritional status and food consumption is available from several sources and is quite complete. The 1976 CDC Survey demonstrated nutritional problems with PCM, vitamin A, Vitamin D, calcium and iron. The Districts of Ratnapura and Kandy were in greatest need of nutritional improvement. Enrichment of bread with ferrous sulfate and calcium has been studied at the Nutrition Medical Research Institute but hemoglobin assays indicated poor absorption of iron. About 70% of animal protein consumption comes from the 11 Kg per capita per year consumption of fish, down from 14 Kg a few years earlier. Soy production is desirable in Sri Lanka from the standpoint of the decline of other protein sources for both food and feed.

F. EGYPT:

The assessment visit to Egypt was made April 25-May 4, 1977. This land has a population of 40 million and increasing rapidly. It is a food deficit country in most commodities; a small but decreasing amount of rice is exported each year. Exported cotton is the main agricultural income producer. Egypt has limited arable land, 6 million acres, which is cropped twice each year. The limiting land expansion criterion is water. Of the 6 million acres, almost one half is planted in clover for one of the two crops planted each year, for animal feed. There are about 13 million animals of which 6 million are donkeys and camels for beasts of burden. Ironically, the clover crop is one which provides a good economic return to the farmer.

The government decrees, in large part, where and what crops are planted. Percentages of many crops are purchased at fixed low prices. It appears that the rural are being "taxed" to support the urban, ie. by subsidizing food prices. The magnitude of this subsidy can be seen by noting that of an annual budget of $LE 7 billion, $LE 1.5 billion is for food subsidies. All imported wheat, eg., is subsidized for urban consumption.

Two million MT of local wheat, no durum, is produced. Approximately 20% of this is purchased at a fixed price of $LE 63.75/MT ($US 82) by the government for urban use; the balance remains in the rural area where it is milled at small artisan mills scattered throughout the country. Fortification through these mills would be very difficult. The Ministry of Trade and Supply which operates the "urban" flour mills pays the government $LE 27.88/MT wheat and sells the flour to the bakers for $LE 28.97/MT.

The balance of the wheat requirement is imported: about 350,000 MT flour from the EEC or the USA and 1.5 million MT soft white wheat. Flour of 72-73% extraction goes totally for pan bread, cakes and pastries purchased by the middle and upper classes. All wheat is milled to 90-94% extraction and this darker flour goes primarily into the production of the flat baladi bread, some 90 million loaves/day (170 gram dough weight.) The overall government costs throughout this system are about 2 piastre ($.028 US) per loaf while the loaf itself sells for 0.5 piastre ($.007 US.) The bread yield per bag of flour is very important because of the bakers' small margin and is said to be 238 loaves for native wheat versus 219 for Mexican dwarf types. As a result, acreage of the higher yielding Mexican types has decreased. Bread riots in 1977 were due to efforts to increase the price of butane fuel and shami (pan) bread from 1.0 to 1.5 piastra. There is only one semiautomatic bakery in Egypt. AID is studying the feasibility of assisting the building of 26 others, but the price structure of flour and bread may not justify such an investment.

Maize production is basically free of government control and therefore farmers like to grow it. Most is white maize for human food. In the Delta, it is common to see baladi bread with up to 30% maize flour. In the south, sorghum flour is blended with wheat flour for making bread. There is about 1.5 million acres in maize, yielding about 2.2 million MT per year. Imported yellow corn is used for feed.

The Nutrition Institute ranked nutrition problems as: (1) PCM in children (marasmus), (2) Anemia in children and adults, (3) Vitamin A deficiency in children and (4) Calcium deficiency in children. No adequate nutrition survey is available. The Center for Disease Control (CDC) is to initiate one in October of 1977, patterned after the Sri Lankan survey, to be completed in 1978. In regard to reaching children with a fortified bread, children start eating baladi bread at about age 2.

FAO has forecast that a measurable impact could be expected through fortification of baladi bread with iron. In 1954, Hofmann LaRoche carried out a feasibility study using local calcium carbonate and ferrous sulfate plus imported vitamins to fortify flour, but concluded it was uneconomic to reach the widespread flour mills. Conceivably, todays centralized mills in Cairo could be reached.

In 1975, Egypt was about 75% self sufficient in meeting its calorie requirements and, presumably, equally low in protein self sufficiency. Faba beans are the main protein source within Egypt, but are currently in deficit and are being imported. Their price is about twice that of wheat flour. Soybean production is experimental. Soy is a host to the cotton worm and for this reason will have to be kept away from the cotton growing areas. Its only hope appears to be in new reclaimed areas some years in the future. Cottonseed meal is available, but contains gossypol and is entirely utilized by the feed industry. In fact, some is now being imported to meet livestock needs. Rice bran exists in large quantities and for a large part (60%) at centralized mills. Up to 70,000 MT are available. At the large modern mills, bran is extracted with hexane and the extracted oil used in soap manufacture. Defatted bran sells for $LE 7/MT ($US 9). Germ is spearated from defatted bran and sells for $LE 30 MT ($US 38.40) for poultry feed. It was the consensus that none of these rice milling fractions would find food useage due to hull contamination and absolute need by poultry and ruminant feed industries. There are no protein sources which are not already being totally consumed. There was no encouragement to divert animal feeds to human food usage, although both Cairo and Alexandria Universities have studied cottonseed protein recovery and use in breads.

Concluding opinions are that the Egyptian government is preoccupied with arranging and financing the availability and imports of food and other materials. Fortification is of only academic interest, the real problem is lack of food. Under such conditions, it is not surprising that many Egyptian government officials, university leaders and US personnel indicated that the government would not pay for any part of a fortification scheme. A further negative was the indication by USAID Mission of their inability to assist a wheat fortification project.

G. MOROCCO:

The assessment trip to Morocco was made May 4-15, 1977. The population of nearly 18 million consumes a diet consisting mainly of wheat and barley. Annual per capita wheat utilization in 1976 was 194 Kg., comprising domestic soft wheat, 29 Kg., domestic durum wheat, 92 Kg., and imported soft wheat, 73 Kg. Of this wheat, approximately one-half is used as food through autoconsumptive means, whereas the remainder is converted into foods via commercial channels. In the urban areas, not less than 90 percent of consumed wheat foods are purchased at commercial outlets; in the rural areas, this figure is about 45. All imported soft (bread) wheat is milled in 65 large mills in Morocco. Data were collected on the 1976 allocation of wheat, the amount of flour sold by these mills on a province basis, and the number of mills in each province. The majority of wheat is consumed as yeast-leavened bread. If bread is to be fortified with protein, the most logical point of fortification would be at a large mill in a province selected on the basis of quantity of flour available from this mill, and the nutritional need.

Potential protein resources for fortification include domestic fava beans, lentils, chickpeas, dry peas and imported soybeans. There are, however, no food grade flours available. There are two large underutilized modern oilseed crushing plants that work on sunflower, cottonseed, and imported soy. These plants would need upgrading to produce food grade defatted soy flour.

Actamine - 5 is a domestic weaning food introduced in 1977 with UNICEF assistance containing 23% wheat flour, 23% chickpea flour, 23% lentil flour, 15% nonfat dry milk, 15% sugar, and vitamins and minerals. This highly processed food is expensive. Opportunities may exist to modify or develop lower cost alternatives.

Barley and corn, both of which are produced in sufficient quantities to satisfy present demand, are lower in price than imported wheat and could possibly be used for composite flour programs to reduce costs of protein fortification and to reduce wheat imports. In times of wheat scarcity, and in lower income households, barley is used at the home level to extend wheat flour in bread preparation.

The one-half to four year old child is the most nutritionally vulnerable group in Morocco, and has been defined by the GOM as the primary target for nutritional improvement. Pregnant and lactating women, and school children are given second and third priority, respectively.

Moderate and severe PCM (less than 80% of norm) was observed in 24-56% of the under age 4 children studied in 1972 among various provinces and prefectures. PCM was most severe in rural areas and in the Bidonvilles (urban shanty towns) and Old Medinas.

The average Moroccan diet was most deficient in riboflavin followed by calcium, vitamin C, vitamin A and niacin. The Government of Morocco is actively involved in nutrition planning with the Interministerial Commission on Food and Nutrition (CIAN) and Cellule de Planification et d'Etudes Nutrionneles (CEPEN) charged with defining and coordinating nutritional problems and research as well as developing a national nutrition strategy. USAID/Morocco and Research Triangle Institute (North Carolina) are cooperating with CEPEN in the develoment of such a strategy.

H. ECUADOR:

As the result of a request from the Ministry of Agriculture to FAO and USAID/Ecuador for an evaluation of the Ecuadorian composite flour project, assessment visits were made October 20 - November 13 by J. Faure, FAO and November 2-14, 1980 by the WRRC Project Manager.

This nation of 7,763,000 people (1979) has a life expectancy of 57. Infant mortality is 65.8 per 1,000 live births. The 1959 ICNND studies found 68% of preschool children in good nutritional status, 27.5 fair and 4.5 poor.

The consumption of wheat flour has increased from 31 lbs per capita in 1963 to 63 lbs in 1978 and now provides 12 to 15% of total dietary calories. The percentage of imported wheat has risen from 53% in 1968 to 92% in 1978. Wheat flour is so heavily subsidized (November 1980) that some is being purchased for animal feed operations. Some 56% of all flour is milled at 2 large coastal mills in Guayaquil and the remaining 44% is milled by 18 small mills in the Sierra.

The Government of Ecuador (GOE) cooperated with Kansas State University and USAID from 1974-1976 on a composite flour program involving the addition of 12% defatted soy flour to wheat flour. The plan was not adopted; domestic soy production was insufficient and capacity to produce food-grade soy flour was not available. The GOE, however, retained interest in composite flours and the Ministry of Agriculture has coordinated and supported a continuing program by the Escuela Politecnica Nacional at Quito (EPN) and the Centro de Desarrollo Industrial de Ecuador (CENDES) on other domestic crops but still including soy. These continuing studies have lead the EPN to recommend a composite flour of 87% wheat flour, 10% low fat corn flour, 3% defatted soy flour but without bread improvers such as sodium stearoyl lactylate (because of the need to import and cost.) The major objective is wheat import substitution with no reduction in protein level of wheat foods.

Ecuador is deficit in food oils and the GOE is supporting increased soybean production which reached 29,000 MT in 1979. There are four solvent extraction, oilseed crushing plants but none has equipment for producing food-grade soy flour. One processor, Oleica located at Guayaquil, has begun upgrading their plant with driers and dehullers but will require more investment before food-grade soy flour is available. Some 10,000 to 13,000 MT of soybeans would be needed to yield the 7,200 MT of defatted soy flour required for a 3% addition to all wheat flour. It is estimated that the avialability of soybean meal for feeds fell short of demand by 10,000 MT in 1980.

Hard corn production has not met demand (estimated at 183,000 MT/year) in the last 2 years by about 45,000 MT each year. Projections, based on GOE increased farmer prices, indicate a closer balance between production and domestic demand. Composite flour with 10% corn flour would require about 34,000 MT of corn, a substantial enough quantity to suggest that an even higher farmer price will be required if demand is to be met. Oleica, the oilseed processor at Guayaquil, has some Italian equipment on hand and is in the process of constructing a 100 MT/day plant to produce raw or pregelatinized, low fat corn flour.

In November 1980, millers were selling wheat flour at the subsidized price of 253 sucres ($US 10) per 100 lbs. Defatted soy flour was projected to cost 484 sucres and low fat corn flour 391 sucres per 100 lbs. Any composite flour program will require the GOE to provide subsidies or adjust prices.

III. Project Proposals

Prefeasibility studies resulted in the elimination of Paraguay, Chile and Egypt as candidate countries for protein fortification of wheat foods. At the risk of oversimplification, the main reason for each was as follows: Paraguay--lack of evidence for need of protein fortification; Chile--other approaches are being used to attack PCM; Egypt--chronic preoccupation with obtaining and financing adequate food supplies. While protein fortification of wheat foods did not appear feasible in these countries, specific vitamin and mineral enrichment projects may be well received and beneficial. In both Paraguay and Chile, there was substantial interest in extending wheat flour with starchy root flours or other cereal flours. The concept of composite flours, though not government policy, is no stranger in Egypt where maize and sorghum flours are commonly used to extend wheat flour for the common Baladi bread.

In order to prioritize the four remaining candidate countries, WRRC prepared proposed protein fortification projects with additional background information for each. The case for Costa Rica is presented in Appendix A-2, for Bolivia in Appendix B-2, for Morroco in Appendix C-2, and for Sri Lanka in Apendix E. These cases were presented at a PASA Annual Review Meeting June 21, 1977. The results of the meeting noted that the Bolivian project proposed a national fortification of bread with soy flour. Morocco called for a regional fortification of bread with soy flour. The Costa Rican project suggested use of Wheat Protein Concentrate (WPC) and/or FFSF in crackers and pasta. While the Sri Lankan project proposed the use of FFSF to fortify domestically milled flour destined for bread, project timing was considered somewhat premature. The conclusion of the Annual Review Meeting was that while all four countries showed sufficient promise for further effort, priority should be given Bolivia, followed by Morocco, Costa Rica and Sri Lanka in that order. In the final analysis, efforts were made to negotiate a project in each of these countries. The successful effort at a project in Bolivia is described in Section V of this report. A summary of each of the unsuccessful efforts in Morocco, Costa Rica and Sri Lanka are described below in Section IV.

IV. Attempts to Establish Protein Fortification Projects

A. Morocco.

In July 1977, the USAID Mission in Morocco was requested to explore with the GOM, their interest in promoting fortification of bread flour with the assistance of WRRC in one province with B-vitamins, calcium and 5% defatted soy flour. Such a model could be easily extended to the other provinces. The time table called for installation of blending equipment at flour mills and refitting of an oilseeds crushing plant to produce food-grade, defatted soy flour by July 1978 and production of fortified flour by January 1979. This proposal was supported by submission of the WRRC assessment report (Appendix C-1) to the USAID Mission and the GOM in August 1977. Table 4 provides information on provinces considered most suitable for the fortification program, the major criterion being high per capita consumption of wheat products prepared from commercially milled flour.

Details of a project were to be worked out in a visit by WRRC in October 1977 and a request for approval of this travel was submitted to the USAID Mission and the GOM. The factor of time was against WRRC. The GOM was working with Research Triangle Inc. (AID funded) to establish enhanced nutrition planning to be followed by "implementations" starting about July 1978. For the GOM to make a decision on a specific nutrition intervention before completion of the planning phase was evidently premature. The GOM disapproved the WRRC visit and Morocco was eliminated from further consideration within the PASA.

TABLE 4

Parameters for Selection of Provinces for Fortification of Flour. There are 30 Provinces and Prefectures.

Parameter	Province or Prefecture			
	Tangier	Rabat-Sale	Algadir	Safi
Population, 1976	326,921	816,766	899,930	610,648
Pop. urban/rural ratio	3/1	6/1	1/4	1/2
No. of Commercial Mills	3	2	1	1
MT flour sold by commercial mills	39,499	70,500	39,654	23,300
Lbs. flour per capita sold by commercial mills	266	190	97	84
% of population residing in Bidonvilles (shanty-towns)	15	18	11.5	-
Socioeconomic region in greatest need, 1971	-	-	1	-
% PCM in 0-4 years, moderate and severe:				
Province	24	34	56	45
City	26	34	40	39

B. Costa Rica

In approving Costa Rica for consideration of a WRRC protein fortification project, DS/N, AID/W emphasized the use of full-fat soy flour (FFSF) and determined that the use of wheat protein concentrate (WPC) would not qualify as a protein fortificant under the PASA. Much of the enthusiasm encountered in Costa Rica during the October 1976 assessment visit, especially with CITA, was for the use of WPC in products for the Assignaciones Familiares Program (AFP) (government food and assistance program for children and families.) In fact, subsequent to the assessment visit, CITA proceeded to negotiate with the GOCR and obtain approval for the concept of WPC fortified crackers and pasta for the AFP. However, because of the DS/N determination, it was necessary for WRRC to drop its planning for WPC and redirect efforts to soy.

By way of background information, soybeans were only produced on an experimental basis at the time of the WRRC assessment in October 1976. CARE/Costa Rica had purchased and successfully tested a Brady extruder at Pro-Nutre, a private Costa Rican company. As a result of that initial work, an Operations Program Grant was signed in 1976 between CARE/Costa Rica and AID for expanding and utilizing soy production in Costa Rica. A Brady Crop Cooker extruder processing plant was to be built for the production of 1,000 MT of CSB and 300 MT FFSF per year on a GOCR site and managed under contract by Pro-Nutre.

The second visit by WRRC to Costa Rica was made November 28--December 7, 1977. A preliminary agreement was obtained with CITA, CARE/Costa Rica and AID wherein WRRC would work with CITA to develop a FFSF fortified pasta for the AFP and FFSF fortified bread for the commercial market. This project proposal is presented in Appendix A-3. The FFSF would be provided by the CARE-AID-GOCR-ProNutre extruder processing plant.

The success of the WRRC project hinged on the timely availability of soybeans and startup of the soy processing plant which at first was scheduled for December 1977 then later moved back to July 1978. The plant actually began operations in June 1979. In addition a change in the Costa Rican government was expected in 1978 and CARE/Costa Rica was concerned that the new government might have different ideas on the use of FFSF than those being considerd by CITA and WRRC. Discussions between CARE and NAG/USDA in January and February 1978 led to the joint conclusion that WRRC involvement in Costa Rica was premature and in light of the WRRC PASA termination date of April 1979, a delayed decision in Costa Rica was not considered desirable. This conclusion was confirmed in the NAG/USDA letter to CARE/Costa Rica in March 1978. Because WRRC arrangements with the CITA had progressed quite far, CARE/Costa Rica was requested to discuss the issue with CITA. Evidently, CITA concurred and wrote to WRRC on March 15, 1978, "--that regretably, because of circumstances, we are obligated to temporarily suspend the project that we had programmed with you for 1978-1979." CITA also noted their intent to concentrate their work effort on the use of WPC as a fortificant for AFP products. For WRRC, Costa Rican involvement was thus terminated.

C. Sri Lanka

Efforts to initiate a project in Sri Lanka were reactivated in February 1978 when it appeared that a project would not be consummated in Costa Rica. This effort started with coordination with INTSOY, the U.S. group assisting the GOSL Soy Development Program. INTSOY indicated increased soybean production in Sri Lanka to 3,500 MT in 1978 with a substantial increase possible in 1979 if pricing was attractive. They also reported progress on the UNICEF/UNDP-CARE funded pilot-plant for processing FFSF, defatted soy flour, and protein concentrates and isolates in that part of the equipment had arrived but utilities were not completed. The CARE-USAID-GOSL Thriposha infant food program was successfully using a Brady extruder to co-extrude corn and soy. Expansion to a new plant site with two Brady extruders was underway.

Based on these improved conditions versus a year earlier, and utilizing INTSOY counsel, WRRC visualized the following project: on a pilot basis, FFSF would be produced by extrusion in a Brady Crop Cooker using the techniques developed at Colorado State University. The remainder of the pilot phase would cover problems and questions of stability of FFSF and the FFSF fortified wheat flour blends, their use in bread production and consumer testing. Based on these experiences and with close coordination with the Soy Development Program, other GOSL agencies and INTSOY, WRRC would prepare or assist preparation of a comprehensive plan for soy fortification of domestically milled wheat flour or flour destined for districts with high malnutrition. Because WRRC would only have had a little over a year to complete the work, it did not anticipate being involved in the actual implementation though INTSOY probably would be.

WRRC proposed to discuss such a project in Sri Lanka with the interested agencies and, together, develop a detailed proposal onsite. INTSOY was in agreement with this approach and WRRC requested concurrence from the USAID/Sri Lanka Mission for travel to Sri Lanka in April 1978. While the Mission was favorably inclined toward a wheat fortification project, concurrence was not granted because of "insufficient time to obtain concurrence from the GOSL." Options were kept open. In May 1978, WRRC met with the Minister of Food and Cooperatives, the Food Commissioner and supporting staff in Washington, D.C. They expressed strong interest in composite flours involving sorghum, rice and blackbeans. WRRC emphasized soybeans. These Sri Lankan officials indicated that a request would probably be issued to the USAID Mission for assistance in preparation of a wheat fortification proposal. In Sri Lanka, discussions reached the level of the President who was reported to be favorably inclined. However, by September 1978, no decision had been reached and no invitations were forthcoming to WRRC. For WRRC, time had run out. Technical assistance for a wheat fortification project in Sri Lanka would have to come from another source.

V. Bolivian Project

A. Environment for a Project

A formal request to seek to negotiate a project in Bolivia was made in July 1977. This request was supported with the document, "Case for a Wheat Flour Fortification Program in Bolivia" (Appendix B-2). Approval was received August 1977 from the USAID/Bolivia Mission and a two member team travelled to Bolivia September 23 thru October 14, 1977.

Prior to travel, WRRC had already determined to try to place the project in the Ministry of Industry, Commerce and Tourism (MICT.) There were 3 major reasons for this: (1) The Agency for Standard and Technology (DGNT) in the MICT had already outlined a composite flour project and had the physical laboratories and assembled team to begin to carry out research and development; (2) MICT had a mandate, issued September 1976, from President Hugo Banzer (Military Government) to study/develop composite flours with "rice, soy, quinoa, and wheat." This mandate was said to include certain privileges for MICT, for example, air shipment of critical items and unilateral authority to begin the project without Ministry of Planning review and approval; and (3) MICT responsibilities in the areas of industry regulation, import/export, price setting, and management involvement in several government owned and operated food processing businesses would be extremely valuable experience as the project moved toward implementation.

The DGNT, MICT composite flour plan was conceived as an import substitution project and did not include a nutrition objective. The nutrition objective of meaningful protein fortification was a non-negotiable requirement imposed by WRRC in return for its assistance. This was also a prerequisite of the Health and Humanitarian Assistance (HHA) Division, USAID/Bolivia for their support of WRRC. HHA was already administering a grant that established a nutrition planning group in the Ministry of Planning. HHA saw the wheat fortification project as an opportunity for the sponsored nutrition planning group to coordinate with a "real world," action project to the benefit of nutrition in Bolivia. HHA had strongly suggested that the project be placed in the Ministry of Planning because that was where the nutrition planners were and where HHA had influence and, in addition, any plan in Bolivia must be approved by the Ministry of Planning before implementation. With the project in the Ministry of Planning, coordination would be assured and approval for implementation more likely and rapid. The WRRC/USAID compromise allowed the project to be in MICT with a project coordinator from the Ministry of Planning. WRRC would have liked to have included a coordinator from the Ministry of Agriculture and Campasino Affairs (MACA) since availability of crops would be in their sphere of influence. However, the competitive natures of MICT and MACA vied against this.

Some additional factors of significance were: (1) Bolivia is geographically and ethnically segmented. From a political viewpoint, any <u>national</u> program must consider equal development. It was important to consider crops from each region for use in the project. Development for the Altiplano is particularly sensitive. (2) The GOB goal for self-sufficiency in food oils mandated increased soybean production but markets needed to be found for the soybean meal by-product. (3) The GOB had built a large oilseed crushing plant at

Villamontes in conjunction with a large irrigation project in that remote area. Because the fortification project would use the by-product of soybean crushing, there was a strong constituency for utilizing this underutilized resource. (4) CORDECRUZ, the Development Corporation of the Santa Cruz Department, had completed a composite flour study and demonstration project and were contemplating what actions to take. Construction of a corn processing plant to produce pregelatanized corn flour for use with pastas was of special interest. (5) A 1975 Decree to add 5% quinoa flour to wheat flour had failed because saponins (bitter flavor) were not completely removed in the quinoa flour manufacturing process thereby affecting bread flavor. Furthermore, the production of quinoa was very limited, its price was rising rapidly and there were lucrative export markets in Peru and Chile. Even so, some 800 MT of quinoa flour was so utilized in composite flour. Improved processes were said to be developed which if coupled with agricultural initiatives might rekindle the quinoa composite flour.

B. Negotiating a Project

Agreement was reached in Bolivia in September 1977 on terms for a joint project. WRRC agreed with USAID/Bolivia to include a coordinator from the Ministry of Planning, Technical Group of Food and Nutrition and in turn, USAID/Bolivia agreed the project should be located at the DGNT, MICT. Contact was made with DGNT and agreement was obtained with them on including a coordinator from the Ministry of Planning and that nutritional improvement would be the primary objective of the project. WRRC agreed to accept soy, rice and quinoa crops (Banzer mandate) as those of major interest. All that remained was to prepare documentation to formalize the project and to include a plan of technical assistance.

The USAID/Bolivia Mission had indicated the need for two documents, Project Design, and a Project Design-Regional. The WRRC PASA would suffice as the Project Design. The task was, then, to prepare a Project Design--Regional. The first draft was written by WRRC on site as daily negotiations proceeded. As a result, WRRC and DGNT were in agreement as to the project contents, but review and approval by USAID/Bolivia, DS/N, MICT and the Ministry of Finance were required. The primary concern of DS/N was assurance on achieving significant protein fortification. This concern was handled by modifying the project goal to specify a minimum protein increase: "The goal is the commercial production throughout the nation of highly nutritious composite flours utilizing wheat, soy, rice and quinoa. A minimum increase of 20% in the protein content of the blends relative to wheat flour is sought. The composite flours will be used in the manufacture of all traditional foods such as bread, pastas and crackers and the acceptability of these foods shall not be diminished."

The project purpose and objectives clearly noted the nutritional nature of the project: "The purpose of the project is to improve the nutritional status and well being of the people of Bolivia by: (1) Improving the protein nutritional quality and quantity of all wheat foods through appropriate blending of flours of wheat, soy, rice and quinoa; (2) Stimulating domestic agriculture and agribusiness to meet the new market demands for soy, rice and quinoa, which result from the introduction of composite flours." The purposes of import substitution and foreign exchange savings were part of the draft Project Design-Regional but were deleted at the request of DS/N. The GOB did not object because these purposes were assured by the nature of the project, whether written or not.

All elements for an acceptable revised Project Design-Regional were in place by November 1977. While the actual revised document was not completed until February 1978, WRRC began work on the project in November 1977. An outline of the Project activities with estimated timing is shown on Pages 31A and B of the Revised Project Design--Regional (Appendix B-3).

In late 1977, USAID/Bolivia adopted the use of a new document called a Grant Project Agreement as the means for effecting a signed agreement between USAID and the GOB on joint projects such as this one. The Grant Project Agreement includes a number of standard administrative sections and a fairly limited description of the project work program. WRRC prepared a Grant Project Agreement (Appendix B-4) which was formally signed 22 June 1978 by MICT, Ministry of of Planning, Ministry of Finance and USAID/Bolivia.

C. Project Amendments

WRRC technical assistance was originally scheduled for completion April 30, 1979, the same date as completion for the PASA. However, there were serious delays in the project caused by: (1) Late delivery on test baking equipment; (2) Delays in customs release of test baking equipment in Bolivia; (3) Political instability. The following series of events details the political instability: Elections in July 1978; military coup August 1978; military coup November 1978; elections July 1979; military coup October 1979; return to civilian government in December 1979; elections July 1980; military coup July 1980. The November 1978 coup led to a change in the Bolivian project manager. The October 1979 coup led to the dismissal of the entire DGNT composite flour team for the month of November 1979 before being reinstated by the following civilian government. The July 1980 coup resulted in a substantial reduction and restrictions by the US on its foreign assistance programs. In light of these delays, project extension to March 31, 1981 for WRRC technical assistance was approved.

D. Project Chronology by Milestones Achieved

Date	Item
2-77	Assessment visit.
9-77	First draft of project agreement prepared onsite.
11-77	Verbal agreement of all parties.
12-77	Laboratory baking equipment ordered.
2-78	Approved Project Design-Regional document in all hands.
4-78	Laboratory baking equipment arrived in Bolivia.
6-78	Official signatures on Grant Project Agreement.
8-78	Laboratory baking equipment cleared customs. Training on soy products conducted at DGNT.
9-78	Engineering plans and cost estimates made to refit SAO soy plant to produce about 10,000 MT food grade defatted soy flour.
11-78	Training on composite flours for DGNT's Technical Director of the Project at IIT, Bogota, Colombia.

2-79 Installation of DGNT baking laboratory completed.
3-79 Economic feasibility study on soy flour.
4-79 Training and test baking on composite flours at DGNT.
5-79 Tests on composite flours at commercial bakeries at La Paz and Santa Cruz.
7-79 Corn flour production begins at PAM, CORDECRUZ at Mairana near Santa Cruz.
8-79 Seminar, 3 days. Held at La Paz with over 100 in attendance.
9-79 Composite flour products tested at week long agricultural trade fair.
12-79 Verbal agreement reached with La Inglesa flour mill to refit the mill to provide commercial composite flour capacity. Equipment ordered.

2-80 Decision on dough improvers; bromate out, ascorbic acid in. SSL is a last resort as mill additive----essentially becomes a bakers choice. First discussions and planning for implementation.
3-80 Physiological acceptance test, 28 days, at a home for children.
4-80 Consumer acceptance tests throughout the country; over 2,000 respondents. Equipment for composite flour mill arrives in Bolivia.
9-80 26,500 pounds composite flours produced at demonstration composite flour mill.
11-80 Commercial bakery and pasta plant runs using composite flours from the demonstration mill.

2-81 Decision made on composite flour blends to recommend for implementation.

a. Immediate addition of 10-25% pregelatinzed corn flour to all pasta at the pasta plants.
b. Addition of 5% defatted soy flour to all pasta at the pasta plants when the soy plant is converted in about one year.
c. Addition of 5% defatted soy flour to all wheat flour at the wheat mills when the defatted soy flour unit is operating to capacity.

Recommendation presented to and enthusiastically received by the Minister of MICT.
3-81 Cost estimate completed to refit all 17 mills to produce composite flours.
7-81 Interministerial committee formed to study and recommend solutions to Bolivia's "wheat problem". The committee will specifically review the project final report (Bolivian) and consider its recommendations.
9-81 DGNT/MICT final report and implementation plan to be presented to the interministerial committee.

E. Soy

Soy is the critical element for protein fortification in this program. Since food grade soy flour was not available in Bolivia, two tasks were apparent. First, soy flour had to be obtained for the research and demonstration phases of the composite flour program. DGNT required that this experimental soy flour be produced domestically. Secondly, plans needed to be evolved for eventual commercial availability of food grade defatted soy flour in quantities sufficient to meet the needs of a national composite flour program.

A soybean expert, Walter Wolf, of the Northern Regional Research Center, USDA, was contracted in August 1978 to provide training to the DGNT on the basic physical, chemical, microbiological and nutritional properties of soybeans and its products and to develop a method for recovery of edible, defatted soy flour from the soybean meal available at the oilseeds crushing, solvent extraction plant, SAO at Santa Cruz.

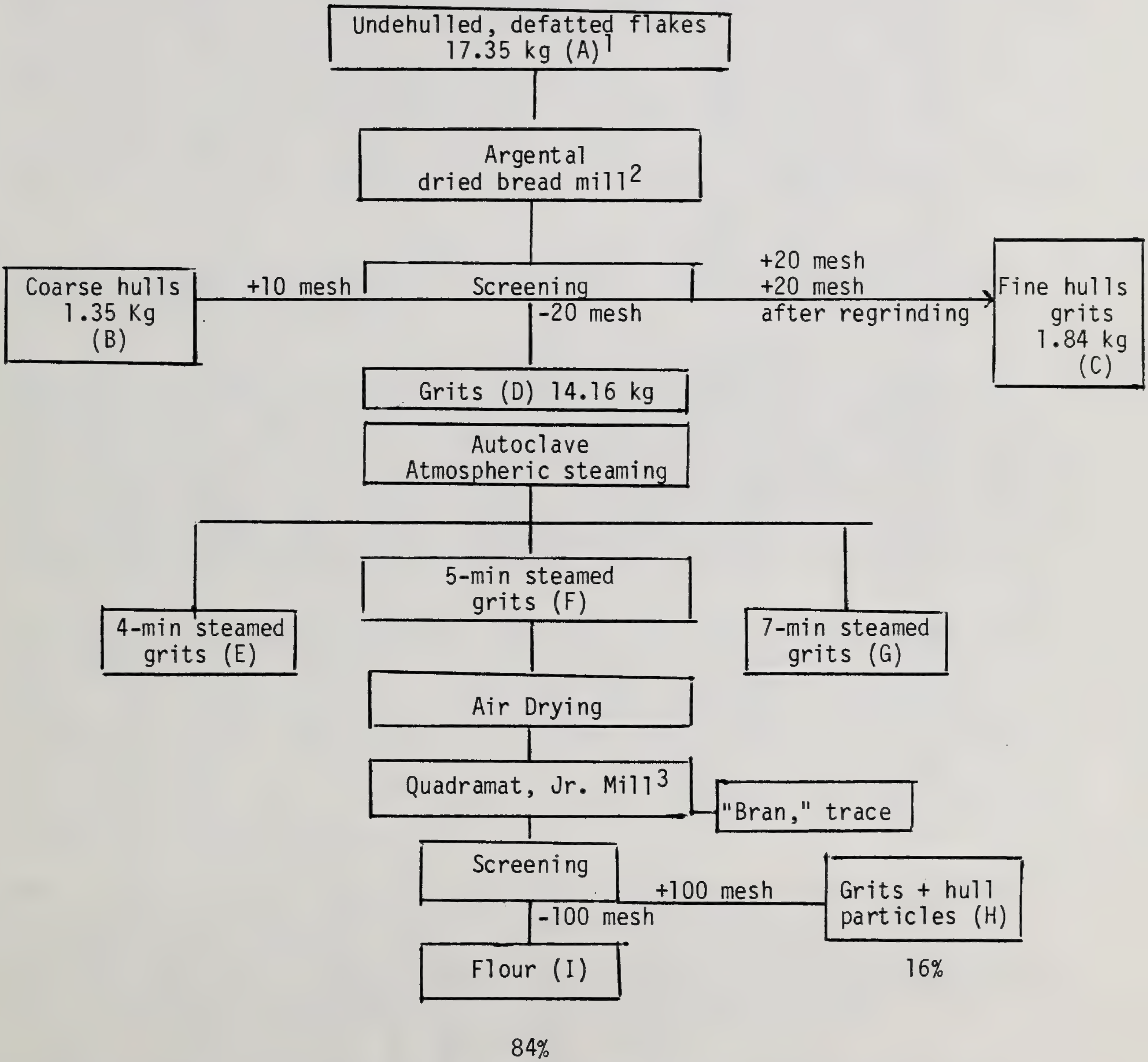
SAO's basic process is: receiving, drying (10.5% moisture,) storage, cleaning, cracking (hulls well loosened but not removed,) "cooking", flaking, extraction in an HLS horizontal basket extractor, desolventizing in a Desolventizer Toaster (DT,) cooling and storing. For experimental purposes, soy meal could be obtained by: (1) taking meal just before the DT and air drying to remove hexane; (2) product from the DT/cooler in standard operation and before addition of gums from oil refining; (3) product from the DT/cooler under reduced heat treatment in the DT but still sufficient to allow complete recovery of solvent and before addition of gums from oil refining.

Figure 1 gives the flow chart developed by Wolf and DGNT for the preparation of an experimental food grade, defatted soy flour starting with soy meal from the SAO plant obtained just prior to the DT (unheated.) With modification, this method could be used with meals taken after the DT. Table 5 lists some of the chemical, physical and microbiological properties of soy products described in Figure 1. The high protein and low crude fiber contents of the flour (and grits) were well within the limits of the usual standards for a defatted soy flour, i.e., 50% minimum protein and 3.5% maximum crude fiber. Normal aerobic plate counts are reported to be 10^2 - 10^5/g for soy flours and proteins. The present samples were in this range. Mold counts were low and acceptable.

This method was generally used to provide defatted soy flours for laboratory work, early experiments at commercial bakeries, for the Consumer Acceptance Test and for the Physiological Acceptance Test. In order to obtain greater quantities of defatted soy flour (about 1 MT) needed to demonstrate the operation of a commercial composite flour mill, SAO agreed to: (1) select the best soybeans; (2) operate the cleaning equipment at optimum conditions; (3) provide an aspiration mechanism for removal of about 30% of the hulls after cracking; (4) reduce heat treatment in the DT to the minimum necessary to recover solvent; (5) refrain from adding back oil refining gums; and (6) provide a coarse grind of the meal by hammer mill. This product was then sieved at La Inglesa wheat flour mill in La Paz using nylon bolting clothes equivalent to about a 130 mesh. A yield of about 30% was achieved. The Nitrogen solubility Index was 28. Total aerobic count was 6 x 10^4/g and molds 3 x 10^2/g. Protein content was 53% and crude fiber 2.5% both on a dry basis.

FIGURE 1

Preparation of experimental soy flour. See Table 5 for chemical and microbiological characteristics of the various products denoted by a letter.



1. Flakes with hulls were taken after solvent extraction and before the DT at the SAO plant in Santa Cruz.
2. The Argental Mill is a slow speed burr-type mill providing a coarse grind.
3. The Quadramat Jr. Mill is a small laboratory wheat flour roller mill.

Table 5

Analytical and microbiological results for fractions obtained in preparation of experimental soy flour. See Figure 1 for further explanation of the samples.

SAMPLE	MOISTURE %	PROTEIN[1] N x 6.25 %	CRUDE FIBER[1] %	NITROGEN SOLUBILITY INDEX		TOTAL AEROBIC BACTERIA/g	TOTAL MOLDS/g
				PEORIA NRRC	LA PAZ DGNT		
Undehulled, defatted flakes (A)	7.7	54.4	6.1	73.7	82.5	7×10^4	9×10^1
Coarse hulls (B)	8.0	24.1	-	-	-	-	-
Fine hulls and grits (C)	8.1	42.7	-	-	-	-	-
Grits (D)	7.6	58.8	2.5	74.4	-	1×10^5	3×10^3
4-minute steamed grits (E)	-	-	-	61.8	65.5	7×10^4	0
5-Minute steamed grits (F)	-	-	-	57.2	55.7	5×10^5	1×10^1
7-Minute steamed grits (G)	-	-	-	51.7	45.6	6×10^4	1×10^1
Grits and hull particles (H)	7.6	57.3	-	-	-	-	-
Flour (I)	7.0	58.9	1.8	53.8	-	6×10^4	2×10^2

1. Moisture Free Basis.

There was some debate on what the Nitrogen Solubility Index (NSI) of the defatted soy flour should be for the uses anticipated by the project. Specifications for US Food for Peace soy-fortified bread flour (SFF) call for lightly heated, defatted soy flour with an NSI of 55-75. Higher NSI's such as these result in lighter color soy flour but antinutritional factors, such as trypsin inhibitors, are not completely inactivated. Where the soy flour is to be reheated, such as in bread baking, this is not a problem. For animal feed, this is a problem and so soy meal is typically well "toasted" (steamed) resulting in an NSI of 10-25. The more intense heating substantially darkens the meals but the nutritional quality is greatly enhanced for direct feed use. The SAO operation is a typical feed operation and the meal is fully toasted and quite dark. Workers in the DGNT associated the feed meal with poor nutritional quality, reasoning that the proteins were damaged by the heat. They were also influenced by the use of lightly heated soy flour in SFF. Substantial proof had to be supplied that low NSI soy flours can have excellent protein nutritional quality for humans.

From the standpoint of functionality of soy flour, loaf volume and color are sensitive considerations in bread. Cooking loss, firmness and color are the major considerations for pasta.

Research at WRRC and the Grain Marketing Research Center, USDA has shown that moderately toasted defatted soy flours (NSI's of 35-45), used at 6-12%, often resulted in better loaf volume (5% greater volume) than lightly toasted (NSI's 55-75) or fully toasted (NSI's 10-25) soy flours used at the same levels. In the case of color, the fully toasted soy flours give a significantly darker bread crumb compared with lightly toasted. The moderately toasted soy flour is just slightly darker than lightly toasted. The major reason why the moderately toasted defatted soy flour was not selected for SFF was one of supply; there was only one producer in the US.

A review of literature (Appendix B-5) indicated that pasta cooking losses were substantially greater when fortified with defatted soy flours but that the losses were minimized with fully toasted compared with lightly toasted soy flours. The fact that defatted soy flours contain 35% soluble carbohydrates probably contributes significantly to increased cooking losses in soy fortified pastas. The addition of soy flours in pastas increases their firmness but one study found this to be, at least in part, due to a reduced rate of moisture absorption during cooking of soy fortified pastas. In other words, soy fortified pastas require longer cooking times.

Where durum semolina is used for pasta production, color is seriously degraded by the addition of defatted soy flours, especially fully toasted ones. The bright amber color is dulled. Where bread wheats are used for pasta, such as in Bolivia, the additon of 5-10% defatted soy flour has only a slight effect on color. For pastas in Bolivia, then, there appears to be a slight advantage in using a fully toasted defatted soy flour to minimize cooking losses.

Because moderately heated soy flour was determined to be best for bread, and fully toasted soy flour for pastas, and because only one type of soy flour is envisioned for the project, it was necessary to select one. The choice was to recommend the moderately heated; the color and loaf volume of bread (78% of all wheat use) was considered more important than increased cooking losses in pasta.

In planning for the future availability of food grade defatted soy flour, the first step was a study of the soybean production and processing situation. This was accomplished by the DGNT (Appendix B-6). In brief summary, there are are 7 oilseed processors in Bolivia with an oilseed crushing capacity in excess of 200,000 MT per year. While the first plant was built in 1968, the first modern solvent extraction plant (SAO) was completed in 1976 and a second in 1978. Soybean production began increasing sharply in 1973 with the harvest of 3,400 MT. By 1978 it was 26,400 MT. One source has indicated 1980 production was 52,500 MT and the 1981 crop is estimated at 70,000 MT.

Soy is processed primarily for its oil content (approximately 20%) and the soy meal has been a by-product with a limited but increasing animal feed market. The key to greater soy production and utilization is additional, profitable markets for soy meal. One such market is food grade, defatted soy flour for use in fortifying wheat flour. Another would be export.

The second step directed to the future availability of food grade soy flour was a technical and engineering study. WRRC contracted soy processing expert Gus Mustakas, NRRC, USDA and EMI Disc Corporation in August 1978, to evaluate the SAO solvent extraction plant at Santa Cruz and recommend and provide cost estimates for refitting this plant to provide a production capacity of about 10,000 MT per year food grade, defatted soy flour. Detailed engineering drawing and cost estimates were completed by EMI and a copy given to SAO. A flow chart and other aspects, especially sanitation, of the current SAO process and the EMI proposed process are described by Mustakas et al., JAOCS, February 1980, p. 55-58.

In the third step, the WRRC economist drew upon the previous reports and, in consultation with SAO and the GOB, prepared an economic evaluation of soy flour production (Appendix B-7). The economist's report (March 1979) concluded that the factors of land, know how, financing, oilseed processing capacity and oil demand are generally favorable for increased production of oilseeds but, inhibited by the small demand for oilseed meals. In this regard, 5% fortification of wheat flour with defatted soy flour would increase the soy meal demand.

Soy flour is usually a joint product in a soybean extraction plant, which also produces soy meal for animal feed. The ratio of soy flour to soy meal cannot exceed a certain maximum without impairing the protein content of the meal and thus its value as animal feed. So as not to exceed this maximum, the production of 8,500 MT soy flour would require the processing of 30,000 MT soybeans and would result in 14,900 MT of soy meal. This is only slightly more than the current domestic demand for soy meal in 1979.

The economist analyzed four possible refits of the SAO plant; (1) head end dehulling with flash desolventizing, (2) head end dehulling with desolventizer toaster, (3) flash desolventizing with tail end dehulling, and (4) desolventizer toaster with tail end dehulling. Each of these options also requires a hammer mill and sieving system to convert the finished flakes to soy flour. The estimated investment costs for modifying the SAO plant range from a high of $US 1,035,000 for flash desolventizer with head end dehulling to $US 435,000 for the desolventizer toaster with tail end dehulling. The highest cost system would have the capability of producing soy flour of good microbiological quality and the flexibility of producing flours in a range of Nitrogen Solubility Indexes

(NSI) suitable for different uses. The desolventizer toaster systems limit production to soy flours of lower NSI's and generally darker color at comparable NSI's.

The estimated costs of soy flour, f.o.b. Santa Cruz range from $US 242 per MT to $US 221 per MT. These prices compare with the subsidized wheat flour price of $US 330 per MT f.o.b. the wheat mill (March 1979). The weighted average transportation cost of soy flour from SAO to wheat mills was $US 24.24 per MT.

F. Rice

High paddy production (112,000 - 127,000 MT/year) during the period 1975-1977 due to attractive GOB fixed prices and other incentives resulted in surpluses of rice. Production has been about 70% long grain types and 30% medium grain types. The GOB encourages long grain production through use of price incentives. In February 1977, at the time of the WRRC assessment visit, methods of disposal of the surplus were of paramount interest, especially since poor rice quality nearly eliminated any export possibilities. It was not surprising, therefore, to find substantial interest in using rice in composite flours. In fact, the Ministry of Agriculture (MACA) with the assistance of the Consortium for International Development (CID) had just completed a feasibility study on a program to extend wheat flour with rice and soy. In that study, dated February 1977, the benefit/cost ratio for a 15% substitution with rice flour was 0.76 and the author concluded it was not feasible. The benefit/cost ratio was adversely affected by the availability of low cost ($US 8.36/qq) wheat flour from Argentina. Argentine millers received subsidized wheat well below the world price at that time and were easily able to undersell wheat flour offered at the world price of $US 12-13/qq or the GOB fixed miller price of $US15/qq. The GOB fixed prices for white rice varied according to quality from $US 7.40 to 18.80/qq. The MACA-CID study used a low grade rice priced at $US 10/qq.

Up to 6,000 MT of rice brokens at the lowest price were said to be available eacy year, but these are used in beer brewing and by poor people (primarily in soups.) Upsurping this supply for composite flours would probably force the brewing industry to import more barley, defeating the purpose of composite flours, and would also be a hardship on the poor. In addition, the collection of all rice brokens from the 40 plus rice mills would be a difficult task.

In light of the rice surplus, the GOB reduced farmer incentives and rice production dropped to 93,000 MT in 1978. This led to the importation of rice in 1979. Interest in rice for composite flours diminished greatly. It should be pointed out that rice demand in Bolivia is substantially influenced by production levels and prices of potatoes and by the availability and prices of pastas, especially short foods.

Two alternatives were considered for making rice flour available for composite flours. The first was to grind the white rice with wheat as is done in the Colombian 3/17/80 soy-rice-wheat flour composite flour program. At the Concepcion Mill, Cajica, Colombia, wheat and rice brokens are tempered separately at 15% moisture. Operating on wheat, the mill normally gives 78-80% extraction. On the rice-wheat mix, extraction falls to 76-78% and even lower if the rolls are not adjusted to be slightly closer than when milling 100% wheat. It appears that the recovery of rice is far from 100% in this type system. The second method was to provide a centralized hammermill and distribute rice flour to the wheat mills for blending. In 1978, Schule Company of Germany provided a quote of $DM 228,000 (approximately $US 100,000) for hammermilling and related equipment to produce 1.5 MT/hour of rice flour (10,000 MT/year.) Mitsubishi Company of Japan was also invited to quote on a 30,000 MT/year rice flour production unit including a building. Empresa Nacional del Arroz (ENA), a GOB rice purchasing, storing and distributing agency that handles 20-30% of the rice crop, was quite interested in 1977 in participating in a centralized

rice flour mill for a composite flour program. That interest, however, declined with the decline of the rice surplus.

To provide rice flour for laboratory or other tests, rice brokens or second or third popular (low grade) rices were milled at the wheat mills of Ferrari Ghezzi at Oruro or La Inglesa at La Paz by feeding the rice into the third break rolls. Recovery of rice flour at the Ferrari Chezzi plant was about 85%. Overs, of course, could be recycled. During a visit in June 1978, the WRRC Project Manager observed several sacks of rice flour produced at Ferrari Ghezzi that had become decidely rancid. The Chief of the Division of Technology DGNT said that rice is somewhat undermilled in Bolivia with 6-8% bran removal. However, the question of stability was never resolved. While WRRC research had shown some textural advantage to the use of medium grain rice in composite flours for bread, information on the class of rice used for experimental rice flour was not obtained.

On January 10,1981, the GOB announced a broad new policy to move toward a "free market." The subsidy on wheat flour was removed and the retail price jumped to the area of $US 24/qq, from the subsidized price of $US 12/qq.

Traditionally, the world price of good quality milled rice is 20 to 30% higher than wheat flour. In Bolivia, however, import costs (transportation) make wheat flour more expensive than the world price and wheat flour and rice prices are more competitive. Some other factors have also changed that reopens the benefit/cost ratio question in 1981. First is the fact that Bolivia is now self-sufficient in wheat milling capacity compared to a need to import 50% of its wheat requirement as flour in 1977. Second, Argentina eliminated the wheat subsidy to its domestic millers raising the price of Argentine wheat flour to the world price. Under these conditions, and with appropriate emphasis on production, rice for composite flour may now well be a reasonable consideration.

G. Quinoa

Quinoa is an annual stock plant, 2-6 feet high, and producing large clusters of small seeds (2-4 mm) in panicles at the end of the stock much like millet. It belongs to the genera Chenopodium, a word derived from the Greek meaning goose foot. The Chenopodium leaves resemble the foot of a goose. Some 60 species are found from Canada to Southern Chile. Chenopodium quinoa is the most economically important species. Quinoa grows at higher and in colder regions than most crops and with as little as 200 mm rain per year (Southern Altiplano).

There are both sweet and bitter type quinoas. The bitterness comes from the 2-4% saponins in the seed coat. The bitter types predominate in Bolivia with the high yielding variety, quinoa Real, being very popular. Production of sweet types low in saponin content require periodic purchase of new seed to keep the varieties pure, a cost that most Bolivian farmers are unwilling to accept. Traditional processing calls for vigorous washing in copious amounts of water to dissolve away the foam-forming saponins. The seeds must then be quickly dried to prevent germination and fermentation. Yield is usually 80-85%. The product is often used like rice.

The production of quinoa, reported by MACA, increased from 9,700 MT in 1970 to 14,960 in 1976 with 64% of production in the La Paz Department, 28% in Oruro and 8% in Potosi. Yield averaged about 760 Kg/hectare. Only about 30% of of production enters commercial markets, the remainder being autoconsumed or bartered. Farm price increased from $b 62/qq in 1970 to $b 144/qq in 1977. The price of quinoa delivered by the farmer to a miller (wholesaler) was $b 165/qq. The wholesale price of quinoa has averaged 53% more than the farm price and in 1977 was $b 213/qq (this product probably has undergone some cleaning). Washed quinoa (saponins removed) prices ranged from $b 250 to $b 350/qq in a 1977 survey.

The inclusion of quinoa in the composite flour project allowed adherence to the GOB policy of "equal development for all regions". Underemployment is especially serious among the small farmers of the Altiplano and Valles. Soy, rice and corn are basically lowland crops. It also provided a continuance of the substantial effort the GOB had already made on increasing the utilization of quinoa.

In January 1975, the GOB decreed (Decree No. 12781) that all wheat flour would have 5% quinoa flour added to it. The Ferrari Ghezzi Company at Oruro was the only major wheat miller to attempt compliance. Field delivered quinoa was cleaned to remove up to 10% foreign matter. Cleaned quinoa was abraded in a vertical cylinder between the coarse iron surface of the cylinder and an inner rotating cylinder with pins. The pins moved the seeds against the outer surface and against each other. Aspiration was applied. Friction was controlled by speed of the pins and degree of loading in the mill. 20.5% bran (based on the starting field quinoa) was removed. Because of the high saponin content, the bran had no value. A second similiar abrader removed

another 4.5% polish which was useful for feed. The final yield was 65% of polished quinoa seeds. Taste tests indicated a 90-95% saponin removal. (Satisfactory chemical methods for determining saponins in quinoa for use in quality control have not been developed). For composite flour, an appropriate level of polished quinoa was added at the third break rolls and co-milled with wheat. Polished quinoa was also sold for traditional uses. Ferrari Ghezzi utilized 12,000 quintales of polished quinoa for composite flours in 1975 out of a total production of 50,000 quintales. Rising farm prices, poor yield of polished quinoa and residual bitterness detected by consumers lead to an early cessation of production. High prices offered for quinoa in Peru and Chile contributed to the domestic price increases.

CETREDE (Executive Secretariat for Economic and Social Affairs, Organization of American States), Ministry of Planning, and ISAP (Institute for Public Administration) published a feasibility study and plan (Desaponification of Quinoa for Use in Composite Flours) in early 1978 for the industrial processing of quinoa. The plan is based on newer technology developed at Ferrari Ghezzi wherein quinoa is cleaned and then lightly abraded on a series of polishers and brushers to remove a large part of the saponins and bran. This is followed by two rapid washes which remove 100% saponin but where water uptake is limited. Drying is done with forced ambient air. Yield of desaponified quinoa is 71%. If milled on a wheat mill, 3% additional bran was lost. The final yield of quinoa flour was 68%. Ferrari Ghezzi was proceeding to build such a plant near Oruro but unfavorable economic conditions forced cancellation.

In 1977, the quinoa price was $b 165/qq ($US 8.03/qq) delivered to Ferrari Ghezzi. By late 1978 it was $b 300-320/qq ($US 15-16/qq). Starting with a base price of $b 300/qq for quinoa, traditionally washed quinoa was $b 450/qq ($US 22.50/qq). The addition of quinoa flour to wheat flour was not economically attractive in 1977 when wheat flour was available from Argentina at $US 8.36/qq and the Bolivian miller price was $US 15/qq. By late 1978, the price of unprocessed quinoa delivered at Ferrari Ghezzi equaled the Bolivian miller wheat flour price; the economics of quinoa for composite flours had deteriorated further.

Bolivia's largest (300 MT/day) wheat mill, Molino Andino, built in 1979 includes equipment for the dry cleaning of field quinoa. This equipment was said to be installed as part of the agreement in obtaining financing from the World Bank. There may be a possibility of co-milling cleaned <u>sweet</u> quinoas with wheat.

Quinoa flours for experimental use in the wheat fortification project were prepared by milling traditionally washed and dried quinoa on a Brabender Jr. wheat flour mill. For larger quantitites, a larger mill was used to grind the washed quinoa.

H. Corn

More land is devoted to corn in Bolivia than to any other crop. Production for the years 1977, 1978, and 1979 was 299,000 MT, 308,000 MT, and 331,000 MT, respectively. Most corn is grown on small farms in a diversity of varieties over a wide area. About half the corn is used on the farm. Domestic demand, about half for animal feed and half for human food, has generally been met.

Corn is traditionally lower priced than wheat and this has also been generally true in Bolivia though the price has fluctuated greatly. The marketing structure for corn and corn products has been described as rudimentary.

In the WRRC 1977 asessment report (Appendix B-1), it was stated that "Corn may be the most economically attractive commodity for wheat substitution". Even though WRRC believed corn was a more viable alternative than quinoa for composite flours, WRRC was willing to go along with the DGNT's emphasis on rice, quinoa and soy in order to obtain agreement on the project. While it was known by WRRC at the time of negotiating a project in 1977 that CONTEC, a Bolivian consulting firm, had completed a project for CORDECRUZ indicating technical feasibility of composite flours using corn, rice and soy, it was not known by WRRC (and presumably DGNT) that CORDECRUZ was in fact building corn storage and milling facilities at Mairana with one of the primary markets to be composite flours for pastas and bread. WRRC learned about construction of the Mairana plant in February 1979, a full two years after the first visit. One Bolivian source intimated that CORDECRUZ was secretive on their project because they felt they could make better progress with minimal national government invovlement.

This slippage in knowledge and thus lack of early coordination with CORDECRUZ was indeed unfortunate and probably significantly delayed the project in terms of coming to a decision on a recommdned formulation for the introduction of composite flours in Bolivia. Considerably more effort could have been spent on studies with corn than were actually accomplished and less time spent on quinoa which had insufficient production and was economically disadvantaged.

The Mairana plant initiated startup operations in July 1979, just 4 months after WRRC's first knowledge of the plant (about 60 miles west of Santa Cruz). The plant was said to be located at Mairana, a tradtional corn producing valley, to reduce the migration of Mairana farmers to Santa Cruz, and of course to enhance national agricultural production. The plant of Mexican design, has a capacity to process 78 MT corn/24 hours with an option for enlargement to 120 MT/24 hours. The corn available nearby Mairana is of mixed varieties but mostly hard yellow. Corn is degermed and dehulled; grits are steam conditioned, flaked, dried, milled and sized. Products are 7% germ, 32% animal feed, and 60% foodgrade grits or flour (raw or cooked). In a 300 day year, the plant has the capacity to produce 14,040 MT of corn flour, enough to substitute for 7% of all wheat flour. One quality control method used to monitor degree of cook in corn flour is Farinograph absoprtion. The desired absorption was said to be 200% for corn flour for use in bread but higher (more severe cook) absorption for corn flour for use in pasta.

To provide corn flour for laboratory testing, consumer acceptance testing, demonstration of the commercial composite flour mill and testing at commercial bakeries and pasta plants, pregelatinized corn flour was obtained from PAM, the CORDECRUZ plant at Mairana.

Considering corn and transportation costs in effect in September 1979, PAM planned to sell corn flour at major cities throughout Bolivia at $b 270/qq ($US 13.50/qq) compared with $b 300/qq for wheat flour f.o.b. the wheat mills. In February 1981, wheat flour was near $b 600/qq ($US 24/qq). Considering the August 1981 World price for corn at $US 6-7/qq, there appears to be adequate room to produce corn flour in Bolivia well below the wheat flour price. In fact, in February 1981, the MICT quoted a price of $b 482/qq corn flour ($US 19.28/qq).

I. Nutritional Considerations

Primary nutritional problems in Bolivia are protein-calorie malnutrition and anemia, whereas goiter and vitamin deficiencies are also important problems. These findings, together with a thorough summary of nutritional status and needs, were summarized in the report of the 1977 assessment trip to Bolivia (Appendix B-1). Specific activities and accomplishments in Bolivia are described in the following sections.

Linear Program. A need for a systematic approach to the selection of levels and types of flours to be blended with wheat to obtain optimum nutritional quality was evident. Therefore, linear programs were developed to address (a) the effect of altering ratios of constituents on protein quantity and quality, and (b) the need to optimize caloric content and protein quantity and quality as prices of the commodities varied. Blending defatted soy, rice and quinoa flours at various levels with wheat flour was investigated by use of the technique. Some of the results are summarized in the presentation, "The Potential Nutritional Impact of the Wheat Flour Fortification Project in Bolivia" (Appendix B-8). Briefly, in order to meet the goal of increasing the protein content 20% or more above that of the initial wheat flour, a minimum of 6% defatted soy flour should be blended with wheat flour. A minimum of 7% defatted soy is required if 5% rice flour is also added. Soy had the most profund influence of these flours on the improvement of protein quality. This is due to the significant quantities of lysine present in the soy as well as its high protein content.

Potential Impact of Wheat Flour Fortification. The potential impact of fortifying wheat flour with selected vitamins, minerals, and incorporating soy, rice and quinoa was critically evaluated (Appendix B-8).

Major nutritional needs and target groups were summarized. The Government of Bolivia (GOB) defined the nutritionally vulnerable groups as those living in rural areas, those less than five years of age, pregnant and lactating women, and school children 5-15 years of age. The effects of wheat flour fortification were evaluated in terms of the nutritional needs of the young child, and women 20-29 years of age. On the basis of daily per capita consumption data for wheat flour, the effect of adding iron (Fe,) calcium (Ca,) thiamine, riboflavin and niacin were assessed. The recommended nutrient intake (Government of Bolivia/USAID, 1978), were used as the criteria for assessing impact of the minerals and vitamins.

If enrichment levels applicable to the U.S. Export Wheat Flour were used, 40% or more of the recommended intake of the three B vitamins and iron would be met for children 1-4 years of age. Thus, wheat flour fortification is an effective means of significantly enhancing the intake of these nutrients by the Bolivians.

The effect on protein quantity and quality of incorporating 5 or 10% soy, rice, and a conbination of soy and rice was evaluated. Rice had a minimal effect on protein quantity and quality. Protein level was decreased 2 and 4%, and amino acid score was 39 and 40 when 5 and 10%, respectively, of wheat flour was replaced by rice flour. Protein content increased by 17 and 33%, however with

the inclusion of 5 and 10%, respectively, defatted soy flour. Soy flour also increased the amino acid score to 52 and 62 when incorporated at levels of 5 and 10%, respectively.

In summary, rice had virtually no nutritional effect using these criteria, whereas soy flour improved both protein quantity and quality of the final wheat-soy blend. The effects of these blends on per capita intake of protein were also summarized. Finally, a program of vitamin/mineral enrichment, and incorporation of soy flour into wheat flour would be an effective means of contributing toward the nutritional goals of the GOB's Five Year Plan.

Vitamin-Mineral Enrichment of Bolivian Wheat Flour. The justification, feasibility and costs of several alternative enrichment programs were critically examined (Vitamin/Mineral Enrichment of Bolivian Wheat Flour, 1979; Appendix B-9). Sufficient evidence exists to suggest that the Bolivian population would benefit nutritionally from an enrichment program. Data indicate that 70% of pregnant females suffered from iron deficiency anemia in 1980, and that there is less than adequate intake of Vitamin A, calcium, and B vitamins, especially thiamine and riboflavin. Previously described target groups consistently have the lowest intakes of these nutrients.

Enrichment programs could consist of iron alone, Fe plus thiamine, riboflavin and niacin, or Fe, B vitamins plus Vitamin A. The merits of using iron in the form of $FeSO_4$, reduced Fe, or electrolytic iron were examined on the basis of stability and Relative Biological Value. $FeSO_4$ would be the form of choice if shelf life of wheat flour is relatively short (<60 days,) since Fe is more bioavailable in this form than in the other forms discussed.

The cost of the three alternative programs was calculated using cost figures of late 1979, on the basis of cost/capita/year, assuming 225,000 MT of wheat flour would be enriched. If iron alone were used, the approximate cost would range from 1.0-1.5 /capital depending on the form used. This cost is increased 3X by the inclusion of B vitamins, and this latter cost is doubled when stablilized Vitamin A is also added. Other considerations such as the need for an additional feeder at the flour mill, and/or the blending of Fe with the dough improvers were discussed.

WRRC actively supported vitamin/mineral enrichment for the composite flours being developed. Nutrition planners from the Ministry of Planning and Coordination and the National Institute for Food and Nutrition also supported this approach to improve the nutritional status of Bolivians. It became clear, however, that the composite flour project was being developed pretty much in the localized domain of the DGNT. In discussing the need for broader GOB participation, the Director of DGNT noted the difficulties of Interministerial cooperation in light of the policitical instability in the country (1979). To achieve cooperation requires substantial communicative efforts at the ministerial level--an effort that is totally lost when a minister is deposed. Another factor that reduced the enthusiasm in the DGNT was the realization that

the GOB financial situation was near desperate; the liklihood of GOB funding for a vitamin/mineral enrichment program was nil. WRRC was unsuccessful in its effort to evoke a working interest by DGNT in vitamin/mineral enrichment.

HHA, USAID Bolivia, on the other hand, was at the stage in 1979 of preparing an expanded nutrition program for Bolivia via a nutrition loan. WRRC collaborated with HHA who sought to integrate support of the implementation of the composite flour project as an element in the several million dollar nutrition loan to begin October 1981. HHA was particularly interested in the vitamin/mineral enrichment aspect. Support of the composite flour project under the nutrition loan was desirable and logical in light of a WRRC technical assistance termination date of April 1980 (later extended to March 1981). There was the possibility of AID funding for the installation of vitamin/mineral feeders and perhaps supporting the first one or two years supply of vitamins and minerals. This development came to an abrupt end with the military coup on July 17, 1980. The nutrition loan was part of the US economic assistance withdrawn in displeasure of the coup.

Physiological Acceptance Study. This study was conducted in response to the Bolivian concern regarding alleged adverse physiological responses of individuals on the Altiplano consuming breads containing soy flour (Vol Ag distributions). Initially, a protocal, including questionaire, was developed for the study (Protocal for Physiological Acceptance Test--Wheat-Soy and Wheat-Soy-Quinoa Breads, 1980; Appendix B-10). This protocal was then used in disussions with representatives from the Ministry of Industry and the Ministry of Social Welfare. This resulted in the development of a formal commitment on the part of these ministries to the specific procedures and responsibilities necessary to conduct this study.

The study was conducted with young Bolivian boys, 7-10 years of age, for a 28 day period. Treatments consisted of marraquetas made from wheat flour alone, 95% wheat flour and 5% defatted soy flour, and 90% wheat flour with 5% defatted soy flour and 5% quinoa flour. Subjects were randomly assigned to the treatment groups and consummed three marraquetas (240 grams or 636 KCal) per day along with the remainder of the menu. One change from the protocal was the substitution of 100 ppm ascorbic acid for the 60 ppm Bromolux (potassium bromate) dough improver. A medical examination was conducted at the beginning and end of the study. Observations were recorded by a Registered Nurse and her staff after they had been trained and familiarized with the questionaire.

Table 6 provides analytical data on the flours and breads used in the physiological acceptance test. A preliminary analysis of the feeding study

Table 6. Analytical and Biological Data on Flours and Breads Used in the Physiological Acceptance Test.

	Proximate Analyses, Dry Basis				Protein Efficiency Ratio	
Sample	Protein	Fiber	Ash	Fat	Actual [3]	Corrected
ANRC Casein Control	-	-	-	-	3.12$\pm$.05[a]	2.50
Wheat flour	12.7[1]	0.4	0.62	1.0	1.18$\pm$.06[f]	0.95
Defatted soy flour	62.6[2]	2.2	7.81	0.7	2.11$\pm$.07[c]	1.69
Quinoa flour	13.8[2]	1.2	2.39	7.6	2.93$\pm$.08[b]	2.35
Marraquetas						
Wheat flour	13.1[1]	1.1	2.00	0	1.39$\pm$.10[e]	1.11
Wheat + 5% soy	14.9[1]	1.3	2.50	0	1.57$\pm$.02[e]	1.26
Wheat + 5% soy + 5% Quinoa	15.4[1]	1.7	2.84	0	1.81$\pm$.04[d]	1.46

1. Nitrogen x 5.7
2. Nitrogen x 6.25
3. Mean Standard Error, Ducan's Multiple Range Test. Means without a superscript letter in common are significantly different, $p<.05$.

results is described in the Report, "Physiological Acceptance Study, 1981 (Appendix B-11). Data collected for each subject throughout the 28-day study included temperature, weight, frequency of bowel movement and consistency of stools. Results indicated that subjects accepted marraquetas from each treatment group equally well. The number of bowel movements per day was slightly higher in the soy and soy-quinoa groups than in the control. In addition, more dry, semi-liquid, and liquid, and less normal stools were produced by groups consuming the soy and soy-quinoa breads than by the control group. These data indicate that children living on the Altiplano, who consumed marraquetas as a normal part of their diet, experienced alterations in their stool pattern when soy or soy-quinoa were added to these breads.

Nutritional Effects of Incorporating Corn and Soy Flour Into the Bolivian Wheat Supply. Since the recommended composite flours are 5% defatted soy four plus 10-25% pregelatinized corn flour for pastas and 5% defatted soy flour for breads and other wheat flour products, the nutritional merits of including corn and soy in wheat products are evaluated.

Various assumptions are made in order to arrive at an approximation of the impact of these programs on an "average" Bolivian. Some of these assumptions are changed from those earlier ones used in the paper "Potential Nutritional Impact of the Wheat Fortification Project in Bolivia" (Appendix B-8). The population is taken at 5.2 million; total wheat milled at 296,000 MT which at 76% extraction gives 225,000 MT flour; protein content of defatted soy flour is taken as 52%, pregelatinized corn flour as 9.5% protein and wheat flour 10% protein; pasta consumption is taken as 18% of all wheat flour and bread as 78%. By calculation, per capita wheat flour availability is about 95 lbs per year.

If 10-25% corn flour was incorporated into the wheat flour used in making pasta, the effect on total protein content and protein quality is minimal. Protein content is decreased 1.3 and 3.2% with the inclusion of 10 and 25% corn flour, respectively. These two levels change the amino acid score of wheat flour (38) to 39 and 40.5, respectively. The minimal effects of incorporating the corn, together with the fact that pasta accounts for a minor portion of total wheat consumption, intimate that the nutritional impact would be insignificant. However, expected social and economic impacts would include reduced farmer migration from Mairana to Santa Cruz, increased farmer income, enhanced agribusiness, and foreign exchange savings on reduced wheat imports.

The results of incorporating 5% defatted soy flour into wheat flour have been previously discussed under the section entitled "Potential Impact of Wheat Flour Fortification" (above). However, based on the current set of assumptions, just described, 5% defatted soy flour in the total wheat flour supply would increase the protein content of pastas and bread by 17%, or increase the per capita daily consumption of protein by 2.3 grams. The influence of 5% defatted soy flour on the amino acid score is to increase that of the wheat-soy wheat foods to 52. In summary, the nutritional effects of including 10-25% corn flour in pastas is negligible, whereas incorporating 5% defatted soy flour into all wheat flour improves protein quantity and quality.

J. Seminar

A three day seminar was held August 22-24, 1979 at La Paz. The seminar program and the seminar conclusions and recommendations are presented in Appendix B-12. In addition to financial and planning assistance, WRRC participated with papers in each of the conference's four sessions:

1) Description of the Project
2) Social and Economic Aspects for the Bolivian Population
3) Crops Being Considered in Developing the Project
4) Technical Aspects of Composite Flours

The seminar had been agreed to in the project plan. It served to directly inform a broader cross section of government and industry, and indirectly, inform the public, through press releases and reports, on the nature and objectives of the project and its progress. The seminar was particularly useful in sparking the interest of nutritional planners. This was later evident as USAID Bolivia progressed in developing its plans for a nutritional loan. A controversial issue arising at the seminar was the use of potassium bromate as a bread improver in the composite flours. A number of participants, especially bakers and millers considered bromate a poison not to be used in food. Many thought there were legal prohibitions against the use of bromate, but a later review of Bolivian law failed to find any reference to the use of bromate at all. Ascorbic acid eventually became the substitute for bromate, but its cost is about four times greater than potassium bromate.

K. Consumer Acceptance

Two activities involving consumer acceptance testing of composite flour products were carried out. The first was distribution of products from the American Embassy sponsored booth at the Second Agriculture, Livestock, Forest and Flowers Fair held at Santa Cruz September 23-30, 2979. The second was through a contract with Centro Boliviano de Productividad Industrial (CBPI) carried out during the period February 1980 - April 1980.

Agriculture Trade Fair. Participation in the trade fair provided needed experience for the DGNT in preparation for and carrying out consumer testing, provided consumer acceptance information on composite flour products and provided a further opportunity to inform and obtain public support for the project. The latter was achieved through person to person contact by the DGNT employees manning the booth and by distribution of a brochure (Figure 2) explaining the project.

The products tested were marraquetas, loaf bread, hamburger buns and other specialty rolls. Blends with wheat flour were: 1) 5-8% defatted soy flour, 2) 5% defatted soy plus 10% rice flours, and 3) 15-20% corn flour partially gelatinized. These products were baked under agreement with a local commercial baker, an arrangement assisted by the Santa Cruz Bakers Association. Potassium bromate (30 ppm) and SSL (0.3%) dough improvers were used in some blends, but the DGNT operators felt that those blends without dough improvers were also successful.

Figure 2. Portion of handout brochure at the Second Agriculture, Livestock, Forest, and Flowers Fair at Santa Cruz, Bolivia September 23-30, 1979.

HARINAS COMPUESTAS UTILIZADAS EN LA ELABORACION DE PAN Y PASTAS ALIMENTICIAS

HARINA	o/o PROTEINA
Trigo	12.46
Soya	53.20
Quinua	11.62
Maiz	8.55
Arroz	8.70

Informes dirigirse a:

DIRECCION GENERAL DE NORMAS Y TECNOLOGIA
Avenida Camacho No. 1488
Casilla Postal 4430
Teléfonos 372047 — 377309
La Paz — Bolivia

MINISTERIO DE INDUSTRIA COMERCIO Y TURISMO
BOLIVIA

AGENCIA PARA EL DESARROLLO INTERNACIONAL
USA

EL PROYECTO

Consiste en la sustitución parcial de harina de TRIGO por harinas de SOYA, MAIZ, ARROZ Y QUINUA en la elaboración de pan, pastas alimenticias, galletas y otros.

POR QUE EL PROYECTO ?

- Porque Bolivia presenta elevados índices de DESNUTRICION PROTEICO-CALORICA.
- Porque el país DESTINA gran cantidad de sus DIVISAS a la compra de Trigo.
- Porque tenemos las MATERIAS PRIMAS adecuadas para sustituir parcialmente la IMPORTACION de trigo.

CUALES SON LOS BENEFICIOS ?

- Elevación del CONTENIDO PROTEICO hasta un 20o/o del pan, pastas, galletas y otros.
- AHORRO DE DIVISAS.
- AMPLIACION DEL MERCADO para Soya, Maiz, Arroz, Quínua y subproductos.
- INCENTIVACION de la producción agroindustrial.
- DISMINUCION de la DEPENDENCIA del mercado internacional del trigo.

QUIENES PARTICIPAN EN EL PROYECTO ?

EJECUCION:
DIRECCION GENERAL DE NORMAS Y TECNOLOGIA (DGNT) del Ministerio de Industria, Comercio y Turismo.

Asistencia Técnica:
WESTERN REGIONAL RESEARCH CENTER (WRRC)
Departamento de Agricultura de Estados Unidos de Norteamérica.

Coordinación:
AGENCIA PARA EL DESARROLLO INTERNACIONAL DEL GOBIERNO DE LOS EE.UU. (USAID)

Colaboración de:
SOCIEDAD ACEITERA DEL ORIENTE (SAO)
COMPLEJO MAICERO DE MAIRANA (PAM—CORDECRUZ)
ASOCIACION DE INDUSTRIALES MOLINEROS (ADIM)
PANIFICADORES — Otras Instituciones

Those visiting the booth were asked via a questionaire to indicate if they "liked", "neither liked nor disliked", or "disliked" the various breads. Control of the testing was difficult because of the high level of activity around the booth; many questionaires "escaped" or were not complete. DGNT workers concluded, however, that acceptance of composite flour breads was excellent.

On one day dedicated to soy, 8% soy fortified hamburger buns were prepared and with the collaboration of ANAPO (Soy ean Producers Association), beef hamburgers fortified with soy were prepared and distributed with excellent acceptance.

CBPI Contract for Consumer Acceptance Testing. The objective agreed to in August 1979 between DGNT and WRRC, was to determine the comparative acceptance by consumers of marraquetas made entirely from wheat flour versus marraquetas made from the following composite flours: 1) 95% wheat flour, 5% defatted soy flour throughout Bolivia; 2) 90% wheat, 5% defatted soy, 5% quinoa flour in the Altiplano; 3) 90% wheat, 5% defatted soy, 5% pregelatinized corn flour in the Valles and Yungas; and 4) 90% wheat, 5% defatted soy, 5% rice flour in the lowlands. All composite flours would use potassium bromate as a bread improver.

WRRC would have preferred to reduce the study to only soy or soy and corn and include a determination of the value of the bread improver, SSL (sodium stearoyl lactylate). For WRRC, time was running out for the project but DGNT would not agree, at this time, to dropping quinoa and rice or relegating them to consideration in some future study. Remembering the GOB policy of equal development for all regions, the DGNT particularly liked one of the proposed decrees that had been discussed. That decree would require mandatory soy foritication of all wheat flour in the nation and further require extending the wheat flour with 5% quinoa, corn or rice---whichever was available, economic and acceptable in a particular region.

WRRC agreed to commit up to $US 10,000 for the acceptance study, agreed that DGNT would be the contracting agent and that WRRC would provide guidelines for a contract. The guidelines, entitled, "Consumer Acceptance of Bread Made with Composite Flours in Bolivia", are presented in Apendix B-13.

Two early proposals from marketing firms were rejected. In reviewing the situation with DGNT in December 1979, modifications of the guidelines were approved by WRRC that dropped the use of rice in Santa Cruz and replaced it with corn and in Cochabamba corn was dropped and replaced with quinoa. In addition testing of a 70-25-5 wheat-corn-soy pasta in homes in La Paz, Cochabamba and Santa Cruz was agreed to.

New proposals were received from Flores Medina (Cochabamba) and CBPI (La Paz). CBPI was selected and a contract signed January 31, 1980. WRRC provided technical assistance to CBPI and DGNT in early February in setting up the tests. At this time, the decision was also made to replace potassium bromate with ascorbic acid as the improver. A preliminary acceptance test was successfully executed in La Paz and CBPI and DGNT were then able to proceed with the full scale acceptance tests.

Results of the acceptance tests are summarized in Appendix B-14. On a scale of 1 (Like very much) to 7 (Dislike very much), the mean acceptance values for various products were as follows:

100% wheat flour rolls	
La Paz	2.19
Cochabamba	2.51
Santa Cruz	1.77
Total	2.16

95% wheat flour, 5% soy; rolls	
La Paz	2.72
Cochabamba	2.59
Santa Cruz	2.76
Total	2.70
90% wheat flour, 5% soy, 5% quinoa; rolls	
La Paz	2.65
Cochabamba	2.20
90% wheat flour, 5% soy, 5% corn; rolls	
Santa Cruz	2.36
70% wheat flour, 5% soy, 25% corn; pasta	
La Paz	2.33
Cochabamba	2.02
Santa Cruz	1.65
Total	2.08

Statistical details are provided in Appendix B-14.

Overall, all products were rated better than 3 (Like a little). However, the 100% wheat flour rolls were preferred over the composite flour rolls. An interesting exception was in the Cochabamba area where composites were comparable to the 100% wheat flour rolls. This might be explained by the recent AID sponsored Soy Utilization Project that had just been completed in Cochabamba. That project had been assisting the promotion and marketing of soybeans in that area for home use.

Comparative acceptance of breads by age groups, socio-economic status, sex, or rural versus urban residence did not reveal any significant trends.

The acceptance of pastas was carried out by leaving samples with families for home preparation. As a result, the ratings were not made in direct comparison with 100% wheat flour pastas. The levels of acceptance for the pastas was considered very good but many people commented that the composite flour pasta required a longer cooking time and that once cooked, were more fragile.

The consumer acceptance tests indicate that acceptable composite flour breads can be made in Bolivia and that a mandatory program where all flour is fortified could be successful. Considering the significant preference for the 100% wheat flour bread, success of a voluntary program would be in serious doubt unless the composite was significantly cheaper.

In the case of pastas, the high level of acceptance with 30% total substitution is very promising. It is known that some corn flour is already being used in pastas since July 1979 because of the economic incentive presented by the availability of corn flour at lower cost that wheat flour. The government attitude on this had been permissiveness as long as there have been no consumer complaints--and there have been none.

L. Demonstration Mill

Wheat millers are an integral part of the composite flour effort and their cooperation is necessary for a successful program. However, they have little to gain and much to lose. Composite flours mean less wheat to mill, and a change in their basic product. The dilution of wheat flour is generally seen as reducing its functional bread baking quality. This is likely to accelerate complaints from bakers. On the other hand, millers recognize that wheat imports are a substantial burden on the Bolivian economy and that the government must contend with this problem. Quotas on wheat imports might be a less desirable alternative to millers than composite flours. In this environment, the ADIM (Association of Industrial Millers) was sympathetic with the government and willing to cooperate to an extent. In discussion with ADIM's president in April 1979, Mr. Petricevic indicated that ADIM could agree with the addition of defatted soy flour to all wheat flour because of the nutritional significance. He strongly opposed extension with corn flour but noted they had no complaint if pasta manufacturers added corn flour.

The demonstration composite flour mill had as its primary purposes the demonstration of feasibility and cost estimation, and secondly to produce product for tests in commercial bakeries and pasta plants.

Contact with the management of La Ingelesa Flour Mill was made in the positive environment of the composite flour seminar in August 1979. The small 10/MT/24 hours mill, located in the La Paz area, was ideal, and management was innovative, flexible and enthusiastic to work on composite flours. A letter of agreement (Appendix B-15) was drawn up to convert and operate the mill as a composite flour mill. The ADIM was notified and while not sponsoring the project, they did not object to their member's (La Ingesa) participation.

Studies of the mill were carried out and necessary equipment and modifications agreed to. The feeders supplied by WRRC arrived in Bolivia in April 1980 and were installed by the end of August 1980. In September, the mill was successfully operated in a demonstration mode to produce four different composite flours:

1) 5% soy, 95% wheat, 100 ppm ascorbic acid: 4 MT
2) 5% soy, 5% corn, 90% wheat, 100 ppm ascorbic acid: 3 MT
3) 8% quinoa, 92% wheat, 20 ppm ascorbic acid: 3 MT
4) 25% corn, 75% wheat: 2 MT

These flours were then tested in commercial bakeries (see section V. N. on "Baking Technology Considerations") and pasta plants.

A cost estimate (Appendix B-16) for equipment for all 17 mills in Bolivia was $US 248,000. This includes a microfeeder, macrofeeder and blender at each mill. Ocean freight was estimated at $US 15,000. Land transportation in South America and installation costs were not determined.

M. Quality Assurance and Regulatory Considerations

It is important that both manufacturers and government regulators have appropriate methods to control quality and insure that products meet specifications. Some efforts were made in this direction but with only limited success. Simple, conclusive methods to detect and quantitiate the levels of corn (raw or cooked), rice, quinoa and defatted soy flour in the range of 1-25% addition to wheat flour are not available. Millers will have to depend on careful monitoring of their feeders and blending equipment to insure appropriate blends. Product use tests such as baking can also be useful for the millers to insure quality. Options for the regulatory area are also restricted and force consideration of such indirect alternatives such as bookkeeping audits to determine quantities of non-wheat flours purchased to see if these levels match, at the right proportions, the wheat flour production or delivery of wheat to the mill (a government controlled function). Another alternative is to have all non-wheat flour purchases by millers pass through a government office.

Fortunately, the problem of quality assurance and regulation in Bolivia is simplified in the recommended implementation which when fully implemented calls for the addition of 5% defatted soy flour to all wheat flours at the wheat mills and 10 to 25% addition of pregelatinized corn flour to pastas at the pasta plants. Because of the high ash content (7%) and protein content (52%) in defatted soy flour compared to wheat flour ash (0.6%) and protein content (10%), analyses for these factors provide significant tools for both quality control and regulation in the soy fortification area.

A problem continues to exist for the pastas since there is no method for quantitating the corn flour. However, the batch blending of pasta mixes better assures accurate blends compared to the continuous feeder/blendor operations to be used in the soy addition. Also, the addition of corn flour to pastas is considered more likely to be accepted on a voluntary basis because of the advantages to the pasta producers: 1) availability of a reliable, high quality corn flour, 2) lower cost of corn flour compared to wheat flour, 3) ability to produce high quality pastas in the 10-25% substitution range, and 4) the inherent flexibility provided by the 10-25% range that allows adjustment for different pasta types and different quality wheat flours.

With respect to the bread improver, ascorbic acid, an indolphenol method was adapted and tested successfully. The method (Appendix B-17) is simple and rapid and applicable to both quality assurance and regulation.

Research efforts were conducted in both the US and Bolivia on means to quantitate the presence of soy flours in wheat flours. One method described in the literature (JAOAC 43(2): 442-444; 1960), based on observing fluoresence emitted by soy flour particles irradiated with UV light, proved unsuccessful. A second method researched and tested in Bolivia was the measurement of stachyose, a sugar in substantial concentration in soy compared to wheat. The effort was based on a presentation at the 1971 AACC meeting in Dallas, Texas, by J. G. Ponte and V. A. De Stefanis (ITT Continental Baking Company, Rye, New York) entitled, "Detection of Soy Flour in Baking Products and Ingredients".

While Dr. W. Wolf (NRRC, USDA technical expert) could make fair estimates of soy content, the triple ascent Thin Layer Chromatography method (see Figure 3) was difficult and lengthy and not suitable for quality control or regulation except, perhaps, in special cases.

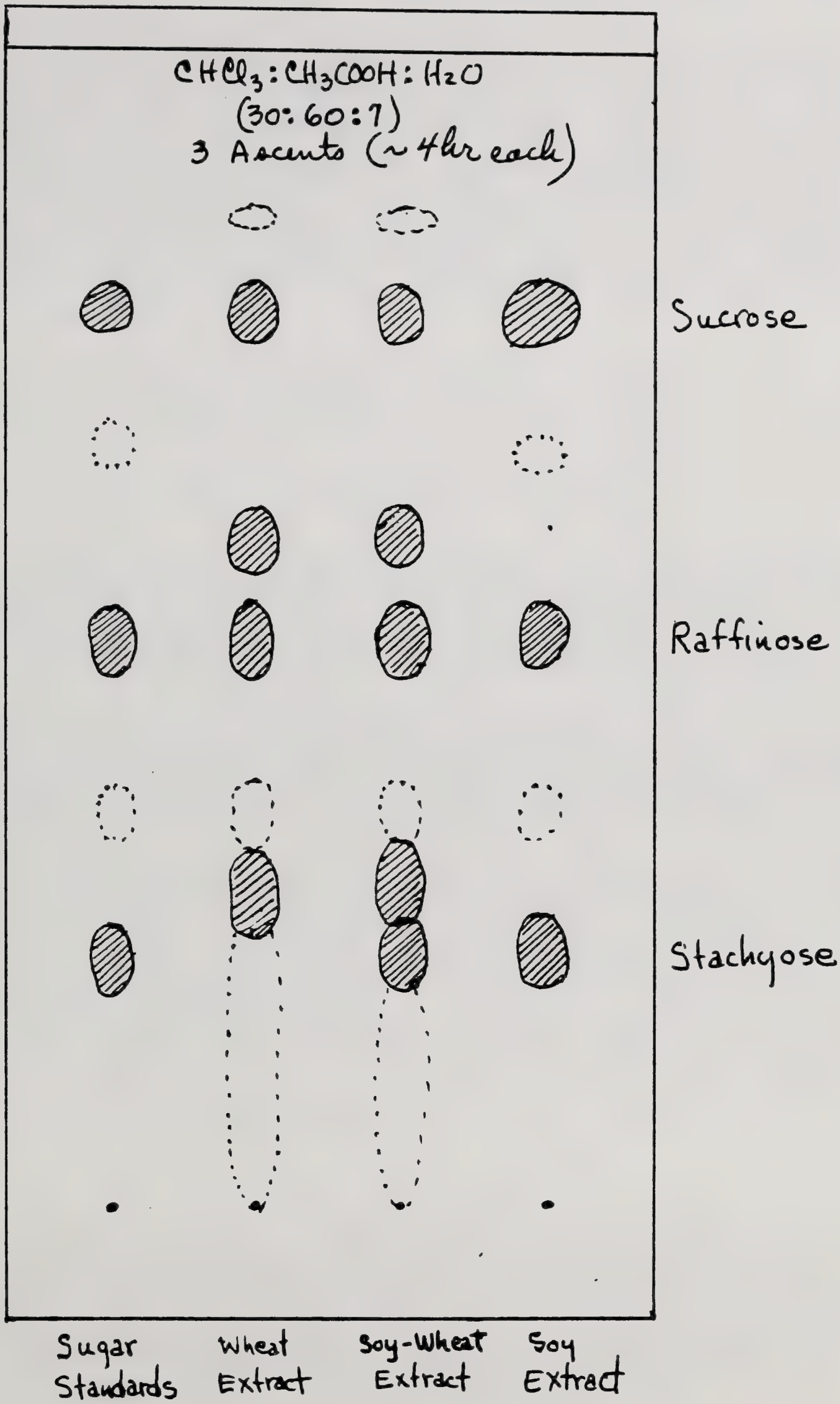


Figure 3 Triple Ascent TLC. Extracts of flours were overnight with $CHCl_3 : MeOH : H_2O$ (1:1:1). TLC plates were coated with Kieselguhr G (25%) : Kieselgel G (75%).

N. Baking Technology Considerations

The baking aspects of this project covered a three year interval during which time several activities were carried out. Baking laboratory equipment was purchased, shipped, and installed in the DGNT laboratory in La Paz. Laboratory scientists were trained in its use and baking tests were conducted on a variety of composite flours using formulas and baking procedures common in Bolivia. The tests were extended to commercial bakeries using laboratory prepared blends. Ultimately, commercially prepared flour blends were tested in a series of trials in mechanized and artisan bakeries in three geographically different locations throughout the country. Many details of these activities are described in Appendix B-18.

During these developments, the DGNT scientists and the WRRC baking technologist enjoyed a close working relationship with the local bakers' associations in each of the three cities visited: La Paz, Cochabamba and Santa Cruz. The bakers were introduced to composite flour technology and to the usefulness of a variety of dough improvers for the most successful products.

Commercial Bakeries. Most bread in Bolivia is baked as small piece goods (rolls), of various sizes, directly on a hearth or on metal trays placed on a hearth. Full size breads (French type - Pan Frances) are also baked in the same manner. A few large bakeries produce limited quantities of pan bread for slicing (Pan Molde).

With the exception of about 6 large bakeries producing a variety of baked products, most of the several thousand bakeries in Bolivia are family-operated shops. Many are small, hand shops using 1 or 2 sacks of flour per day with all operations by hand. These are referred to in this report as "artisan" shops. The smallest may be household operations whereby dough pieces are made up, taken to a neighborhood oven for bake-off and then sold in a store fronting on the family quarters. Probably the largest volume of bread products is produced in hundreds of medium-sized bakeries with various levels of mechanization. They may use 5 to 25 quintales of flour per day and are located in large towns and cities throughout the country. The owner/operators of these shops form the nucleus for the very active national and local bakers' associations. These groups were a major contact for this project. Most of this report will deal with activities in these medium sized bakeries referred to as "mechanized" shops.

Labor

The owner and family perform much of the work in the bakery which is usually adjacent to, and sometimes part of, the family living area. When helpers are used, their pay is usually geared to the number of sacks of flour processed and to their level of responsibility in production.

Ovens

Typically, bakeries are one large room with a brick or metal hearth oven located

along one wall and having the capacity for the marraqueta yield from 1/2 quintal of flour. Some have two ovens if production warrants. Brick ovens are kerosene-fired directly into the hearth for several minutes before baking. Depending on heat retention, baking proceeds for several hours until the oven has cooled and needs re-firing. For more primitive artisan operations, a wood fire is built directly on the hearth of small beehive ovens and pushed to one side to maintain heat during baking. Metallic hearth ovens often have a separate oil, gas or wood fired chamber with pipes directing heat to oven floors or overhead. Some are equipped with steam generators which deliver a controlled amount of moisture to each bake. By contrast, the brick hearth ovens have minimum venting and depend on moisture accumulation during baking. Thus, richness of crust color improves from the first to the last batch.

Mixers

The most common type of dough mixer in mechanized Bolivian bakeries is the slow-mixing SIAM-UTIL. Two sizes are common. The smaller size mixes doughs from 1/2 to 2 quintales of flour and the larger holds up to 5 quintales. The bowl rotates at 4 rpm. Mixing is provided by a double hook which turns the dough over 10 times per bowl revolution. This works each portion of dough 4 times every minute. A stationary scraper continually insures cleaning the dough from the walls of the bowl. Dough mixing time ranges from 15 to 40 minutes. While blending is efficient, dough development is negligible even after 40 minutes. Additional development is sometimes provided by a dough brake (sobadora) or by hand kneading, usually after fermentation. A few bakeries have mixers equipped with a more efficiently designed agitator and more rapid bowl rotation, resulting in more dough development in less time. All are of the open bowl design.

As Bolivian bakers become more exposed to projects such as this and visit other countries, they are developing a keen interest in upgrading their equipment and processing methods. During the final bakery trials of this project, one baker was sharing advertising on a new Brazilian mixer she had purchased. This mixer develops doughs faster and more efficiently, resulting in an increase in her bakery's output sufficient to pay for the mixer in about 2 years.

Fermentation

Doughs are fermented in stationary wooden troughs often large enough to hold several doughs from successive batches. Some bakers have small troughs on wheels for individual doughs. The last dough of the night may be fermented in the mixer. Water is heated to achieve dough temperatures between 25 and 35°C, but ambient temperature is often the only subsequent control. This may be over 40° in the tropics and under 20° on the altiplano. Some bakeries have built chambers at one side of their ovens to serve as fermentation rooms.

Dough Brake (Sobadora)

Bakers who produce specialty breads other than marraquetas, routinely use a dough brake to provide gluten development for undermixed doughs. From 5 to 15 Kg. of dough are passed through rapidly revolving rollers several times providing a sheeting action. By judicious setting of roller clearances, a baker can progressively develop a dough by causing tearing action at close settings, folding the dough piece after each pass, and eventually opening the rolls to produce a smooth, well developed dough after 30 to 40 passes. Because of the added time and labor costs, bakers are reluctant to use the dough brake for marraquetas, a price controlled bread. It should be noted that this type of dough brake is not allowed in the U.S. because of the lack of appropriate safety features in its operation.

Dough Dividers

In mechanized bakeries, portions of dough are cut into predetermined sizes in hand-operated bun dividers. For example, 3000g of dough are cut into 30 pieces of 100g each for marraquetas. Without a bun divider, marraqueta dough pieces must be weighed individually to conform to legal baked weights. This is probably the most time consuming operation of the entire production process. The skill of the baker and helpers in estimating dough weights correctly and rapidly is significant in determining their total daily production and hence income.

Make-Up

Marraquetas and other French-style hearth breads are formed by hand or processed through a sheeter-molder which yields a typical elongated roll with tapered ends. Finished dough pieces are proofed on cotton cloth placed on boards or trays. Proof-time is determined by feel of the doughs by the experienced baker. Doughs are manually transferred to trays or peels for placement on the oven hearth. Transfer is rapid and not very gentle. (See page 63 for further discussion of shock abuse and dough strengtheners). Baked breads are transferred directly from the oven to large baskets and sold in bulk quantities for resale by small vendors. The consumer purchases individual pieces in the marketplace or in stores.

<u>Test Baking Laboratory in Bolivia</u>. In November-December 1977, appropriate test baking equipment was selected and purchased in the United States for delivery to WRRC for final crating and shipment to La Paz, Bolivia. Crates were shipped in March 1978 by surface to Miami, Florida, from there via Lloyd Aero Boliviano (LAB). They arrived in La Paz in April 1978. They were released from customs and installed in a new laboratory facility at DGNT by February 1979.

Equipment

The equipment selected was similar to that used in test baking facilities in the United States. This provided the DGNT laboratory with a technical capability for scientific baking experimentation, results of which could be compared with overseas laboratories. At the same time, the equipment was adaptable to conditions approximating baking systems within Bolivia by judicious changes in procedures, temperatures and humidity conditions. The equipment chosen also complimented that already on hand in the DGNT facility, namely a Brabender farinograph, extensograph, amylograph, roller mill jr. and moisture tester. The U. S. equipment was donated through the USAID to the Government of Bolivia. A description follows:

1) Dough Mixer, Hobart A-200, equipped with 12 and 20 qt. bowls, whip, flat beaters and dough hooks and a McDuffee bowl and fork.

2) Fermentation cabinet, 2/3 size, National Mfg. Co.

3) Dough sheeter and molder for pup and pound doughs, National Mfg. Co.

4) Loaf Volumeters, pup and pound sizes, National Mfg. Co.

5) Balance, Toledo Computagram, 5 Kg capacity, Toledo Scale Co.

6) Reel Oven, one pan wide, 4 revolving shelves, equipped with a steam generator, Chubco Co.

7) Miscellaneous: bun and loaf pans (pup and pound), hygrometer, thermometers, spatulas, timers.

Where applicable, electrical devices were obtained to operate on 50 cycle current. The equipment was put into operation in February 1979. Because of laboratory plumbing problems, the steam generator was not used beyond the initial start-up. All other items proved satisfactory for a laboratory facility.

Baking Methods

Recognizing the predominance of hearth bread and rolls in the Bolivian marketplace, laboratory tests included baking performance in marraqueta-type rolls. However, in order to obtain laboratory data that could be compared between and among experiments, pan breads were baked from the same batch of dough as used for the marraquetas. Laboratory pan breads included PUP loaves baked from 150 g of dough and POUND loaves baked from 560 g of dough. Marraquetas were baked from 80 or 100 g doughs. In this report, loaf volume results are compared for the pan breads. The formulas used followed those suggested by bakers for marraquetas. These are lean formula breads containing flour, sugar, salt,

yeast and water. For composite flour trials, several dough strengthening agents were used, e.g., oxidizing agents, surfactants and shortening. Baking tests were carried out on dough batch sizes based on a minimum of 1000g flour in the laboratory to 23 kilograms (1/2 quintal) in the bakeries. The major criteria for judging the products in the laboratory were handling properties of the doughs and flavor, color, odor and volume of the baked piece. In the bakeries, these factors plus the character (boldness) of the break on top of the marraqueta were the major criteria. This latter characteristic is produced by slashing the dough surface with a razor just prior to baking, thus permitting expansion of the bread at this point. To the baker, a bold, large break with a smooth shred where the dough has stretched, indicated a well-developed dough with optimum oven expansion. To the consumer, it provides appetite appeal. Since these rolls are usually chosen individually from a basket at the point of sale, the character of a well-developed break is a potent sales feature.

Dough Improvers. The WRRC project in Bolivia was an extension of previous investigations that had demonstrated the feasibility of adding up to 12% soy flour to wheat flour and minimizing or eliminating any adverse quality effect by the addition of the dough improver, sodium stearyl-2-lactylate (SSL). During the course of this project, this and other surfactant-type dough conditioners were evaluated under Bolivian conditions along with the oxidizing agents, potassium bromate and ascorbic acid.

Bolivian Experiences

In the past, Bolivian bakers have not had ready access to oxidizing agents or surfactant-type dough conditioners. That is changing. Since 1979, a line of four products has become available through the company that produces yeast (Industrias Venado, S.A.). These would appear to have been the first such products advertised in the public press in Bolivia for improving breads. They are produced in Brazil and include the following, with descriptions as given on the labels and in advertising:

PANCEL - powder, gluten improver, vitamins;

PANZIME - powder, enzymatic regulator, diastatic activity;

LACTOPAN - oil, powerful emulsifier;

ANTIMOHO - powder, antimold agent.

The recommended use level at the prices prevailing in 1979 would add approximately 6% to the cost of a quintal of flour if all were used in combination.

While dough improvers were not in common use in Bolivia when our project began, many Bolivian bakers have known of the usefulness of potassium bromate and ascorbic acid. Some have suggested the use of bromate in specialty doughs which are

usually sweeter and richer than marraquetas. These doughs are developed on a dough brake (sobadora) after a short fermentation time of one to two hours. Some bakers felt such doughs benefited from the bromate, others felt if they contained bromate they needed the additional development contributed by the dough brake. One of our tasks was to determine if composite flour doughs containing bromate needed additional development beyond that normal to marraqueta production.

Cost

In the initial stages of the project, potassium bromate became the key dough improver necessary to strengthen doughs carrying 5 to 10% non-wheat flours. It was the dough conditioner of choice because it was the least expensive, adding only 0.1% to the cost of a quintal of flour. Ascorbic acid was 2 to 4 times more costly due to a higher usage level and a higher material cost. The surfactant-type dough conditioners were considerably more expensive at the effective use level adding 2 to 3% to the flour cost.

Safety

As the project developed with potassium bromate, some concern was expressed as to its safety for humans. Copies of reports on toxicity studies conducted in England were made available in English with Spanish translations of summaries. Additional references to FAO Codex standards were supplied along with observations on the long history of use of bromate in the United States and other countries with no adverse effects demonstrated in human health. These studies failed to convince the decision makers in Bolivia as to its safety at the levels we would be using (20-40 ppm) in the flour. They eventually opted for ascorbic acid at 100 to 150 ppm added at the flour mill, with the surfactant-type dough conditioners to be the choice of the baker.

Function

Dough oxidizing agents, potassium bromate and ascorbic acid, proved effective in counteracting most of the dilution effects of up to 10% non-wheat flour in laboratory tests. However, initial bakery trials showed they did not overcome all the handling shock associated with commercial systems, even in the labor intensive systems predominant in Bolivia. Individual dough pieces are often handled 2 to 3 times between make-up and baking. Typically, hand or machine-molded doughs are proofed on cloth-covered wooden boards, then transferred to an oven peel, slashed with a razor blade to provide the typical french bread cut, then slid into an oven. Handling is rapid and not gentle. The baker tends to push his/her fingers firmly into the dough while slashing the top with the other hand. When the doughs are slid from the peel onto the hearth of the oven, the movement is sudden, to aid transfer, and many doughs collapse noticeably,

similar to that exhibited by shocked doughs on conveyor belts in highly mechanized systems. Dough conditioners, which impart strength for the mechanized systems, also proved helpful in the hand operated bakery providing tolerance against abuse and enhancing volume potential.

Dough improvers, known to complex with proteins during dough mixing, yield their maximum effect in well-developed doughs. In Bolivia, this concept is important because many bakeries have slow mixers which do not develop gluten strength to the optimum for maximum performance. Some doughs have additional development by hand kneading or by several passes through the dough brake, usually after fermentation. In general, marraqueta doughs do not receive additional development beyond that imparted by the slow mixer.

To demonstrate the effect of dough development on dough conditioner function, laboratory tests were conducted using a composite flour containing optimum potassium bromate, with and without the dough conditioner, SSL. Loaf volume response to potassium bromate was somewhat improved with dough development (1700 to 1750 cc volume). Response to SSL was markedly improved (2050 to 2620 cc volume). Without dough development, the SSL improved loaf volume over that with bromate alone, 2050 vs. 1700 cc, demonstrating a significant effectiveness in minimally developed doughs.

SSL Levels

The effectiveness of surfactant-type dough conditioners in successful application of composite flour technology is well documented worldwide. A major factor limiting applications in developing countries is its cost which can add 2 to 5% to the price of a sack of flour. This increase becomes more significant to the baker of price controlled products where the additional cost cannot be passed on to the consumer.

Initial experimentation and testing of composite flours in Bolivia assessed dough conditioner response at the 0.5% level, prevelant in U.S. commercial applications and in P.L. 480 soy-fortified flour. In laboratory tests in La Paz at 12,000 ft. elevation above sea level, composite flour marraquetas with 0.5% SSL had such high volumes that they were not acceptable to the consumer. Subsequent studies indicated a level between 0.2 and 0.3% was sufficient with 10% non-wheat flours. Below 0.2%, bread improvements were marginal. Final recommendations suggested at least 0.2% SSL as the most cost effective level of addition. This could be added at the mill with current feeder technology or could be added by the baker at dough mixing. For this project, the additions were made at the bakeries.

Crumb Problem

A typical defect exhibited in pan breads in the altiplano area of Bolivia is a weak or torn crumb area about 1 to 2 cm below the top crust and parallel to it.

While not produced by the same causes, it is similar to crust separation occurring when excess vacuum is used to depan bread in mechanized systems. It occurs during cooling when the fragile crumb contracts pulling away from the more rigid crust. It is a more common fault in the high altitude regions than in the tropical lowlands. Doughs expand more during baking at 12-13,000 ft. due to the low atmospheric pressure and reach a lower internal temperature (87 to 88° C) limiting heat setting of the protein-starch structure. Both factors contribute to a more delicate crumb with less cohesive strength, thus vulnerable to tearing during the rapid cooling contraction in the high, dry climate.

Experiments with composite flours and dough conditioners indicated that both the non-wheat flours and the dough conditioners markedly improved this problem, essentially eliminating it. Dough oxidizing agents and surfactants presumably acted by strengthening the crumb structure through their interaction with proteins. Such effects have been documented in world literature on scientific studies of dough improving agents. When the non-wheat flours were present without dough conditioners, they also eliminated the torn crumb structure. The reasons are not apparent except that, without the improvers, the non-wheat flours diminished loaf volume. Perhaps the more compact crumb was less vulnerable to tearing.

Laboratory Tests. Laboratory baking trials were initiated in February 1979 to test the new equipment and to train the DGNT scientists. Wheat and non-wheat flours were test-baked during several visits of the WRRC baking technologist and at many other times by the DGNT scientists in a host of experiments related to this and to other projects of the DGNT.

Ingredients

All traditional bread ingredients used in the baking trials had been processed in Bolivia. With the exception of wheat, which is imported, all raw materials were produced in Bolivia. Granulated sugar and salt were refined products but had a coarser particle size than similar products in the United States. Yeast, produced in a plant in La Paz, was available as the fresh compressed or active dry product. Generally, the fresh compressed yeast is limited to the market area within 30 minutes by air or land transport from La Paz.

Wheat Flour

Most of the wheat flour consumed in Bolivia is milled in 17 rollermills situated throughout the country. Wheat is imported and is typically represented by U.S. Hard No. 2. At the beginning of this project, the legal extraction rate for flour was 72%. In 1979, a new government changed the legal maximum to 76% extraction. Flour is sold in 100 pound cloth bags. One sack is a quintal which weighs 45.359 Kg, usually rounded off to 46 Kg for calculating bakers

percentages. Proximate analysis of several flours used in this project were as follows:

Flour	Moisture %	Protein[a] % as is	Ash % as is
A	13.0	11.4	0.57
B	14.0	9.5	0.38
C	13.4	11.7	0.72
D	12.6	14.5	0.79
E	13.2	11.2	0.54
F	11.9	11.3	0.60

[a] Nitrogen X 5.7

These flours were unbleached and did not contain maturing agents, vitamins, minerals or enzymes.

Soy Flour

Food grade soy flour is not commercially available in Bolivia. A major goal was to encourage the establishment of processing facilities that would provide defatted soy flour for composite flours and for other food needs. Another AID-supported project in Cochabamba was developing marketing aspects for whole soy beans. Both projects developed a keen awareness of soy potential in the processors and in the consumers alike.

Soy flours for test baking were prepared in the DGNT laboratory from defatted soy bean meal provided by SAO (Sociedad Aceitera del Oriente), a soy oil processor in Santa Cruz, Bolivia. Flours were prepared by a laboratory method developed during the technical assistance visit of Dr. Walter Wolf of NRRC, a sister laboratory to WRRC, located in Peoria, Illinois. After autoclaving and rollermilling, the flour that passed through a 100 mesh sieve (including coarser fractions remilled) was used for baking. See Section E, page 32, of this report for methods and non-baking aspects of the soy flour situation in Bolivia.

Baking tests compared the DGNT produced soy flour with 3 commercial US defatted soy flours representing the full range of toasting treatments. The loaf volume results were essentially similar for all soys and indicated a positive response to potassium bromate at the 40 ppm level in 5% soy additions. Subsequent trials with other wheat flours indicated 30 to 40 ppm of potassium bromate or 100 ppm

ascorbic acid was necessary for 5 or 6% soy flour when it was the only non-wheat flour in the blend.

Additional tests compared baking results of composite flours containing DGNT soy flour with blends containing rice or quinoa. These tests indicated that lower levels of soy (5%) could be added in a blend to yield bread quality equivalent to 10% rice or quinoa or 100% wheat flour bread; the latter baked without dough conditioners, the composites containing 20 ppm potassium bromate.

Further tests with Bolivian soy flour in combination with rice or quinoa, (usually 5% of each) indicated the need for SSL or another surfactant-type dough strengthener with the oxidizing agent. This observation followed with all combinations at the 10% level or greater.

Because the hulls are not removed in the initial oil seed crushing process, the Bolivian soy flour tended to have a darker color than US products at comparable PDI values. The bread crumb was somewhat darker with soy. However, no off-flavors were detected in the flours or breads made with Bolivian soy flours.

Rice Flour

Rice flour is not a commercial product in Bolivia and was produced especially for this project. Initial tests were made on flours prepared in a laboratory roller mill (Brabender Jr.). Two commercial wheat flour mills were subsequently used to produce larger quantities of rice flour. The first tests compared the laboratory product with a commercial U.S. rice flour in composite flour blends containing 10% rice with and without potassium bromate. The slightly higher loaf volumes with the U.S. rice flour were not significant. More important was the response of both 10% rice flour blends to 40 ppm potassium bromate yielding volumes comparable to those obtained with wheat flour baked in the same formula without bromate.

An important physicochemical difference between the two rices was their estimated BEPT (birefringent end-point temperature) of the starch (62° C. for U.S. rice; 67° C. for DGNT rice). This starch gelatinization characteristic can be important if large quantities of rice flour are used in composite flour blends. Research at WRRC has shown that rice flours with low gelatinization temperatures (BEPT below 65° C) and low amylose values (below 20%) give soft texture to bread crumb. In the U.S., these characteristics are typically represented by short and medium grain rices which have soft, sticky characteristics as cooked whole kernels. The U.S. rice flour tested in Bolivia had these characteristics. These contrast with characteristics of long grain rices which generally have BEPT temperatures above 70°C and amylose values above 20%. They impart a sandy characteristic to the texture of baked products.

The Bolivian rice flour used in these experiments had a BEPT that was intermediate between those commonly found in the U.S. (67°C) and an amylose content of 24%, similar to U.S. long grain rices. Other Bolivian rices examined had BEPT's of 69°C. In general, Bolivian rices studied were more typical of long grain varieties in kernel length and physicochemical characteristics. Two Bolivian scientists detected a softer, more pleasant crumb characteristic in the breads containing the U.S. rice flour milled from short and medium grain rices.

Quinoa

Chenopodium quinoa Willd is the most common species of quinoa (keý no a) grown and consumed throughout the high Andean countries. Other Chenopodiacea grow wild but this species is cultivated and apparently has been since ancient times. Seeds have been found in the pre-Inca ruins of Tihuanaco, a 10,000 year old center of culture located near Lake Titicaca at 13,000 feet altitude.

The unique food aspects of quinoa are it's protein content (11-14%), high lysine content (6.5% of protein), and extremely small starch granules (about 1 micron diameter) containing about 20% amylose and a BEPT of 55°C. The harvested seeds are small (about 2mm). The germ or embryo is located in an equatorial groove surrounding approximately 3/4 of the seed. A large portion of the total seed protein is located in the germ. The four pericarp layers comprising the seed coat contain significant levels of saponins which must be washed out before cooking to eliminate the bitter taste. Some so-called sweet quinoas need less washing because they contain no saponins or saponins that are not bitter. Scientists working in the field believe the sweet quinoas contain saponins but at a very low level. People who have been eating quinoa for centuries have no endemic disorders which would implicate quinoa.

Baking tests with quinoa were concerned with it's functional effects in wheat based composite flours and the need for dough additives. While there was a decrease in loaf volume of breads with 5 and 10% quinoa, it could be counter-acted with potassium bromate added at 20 or 40 ppm to produce breads similar to wheat bread without dough additives. Subsequent commercial trials suggested 10% non-wheat flour blends should have surfactant-type dough conditioners in addition to the oxidizing agent. In final bakery trials, 8% quinoa with 100 ppm ascorbic acid was successfully used in composite flour blends for the tests in the Altiplano.

Quinoa flours did not present any unusual problems in composite flour breads beyond that expected by the dilution effect. Dough absorption adjustments were minor or non-existant for quinoa additions. The flour was whiter than wheat flour but had a grey cast (compared to yellow in wheat flour). At the 10% level of addition the bread crumb was whiter with slight grey overtone.

Commercial Bakery Trials. The first bakery trials, after initial testing in the DGNT laboratory, were held in mechanized bakeries in a suburb of La Paz and in Santa Cruz, comparing composite flour performance at two altitudes (12,000 feet and 1,350 feet) and in two climates (early winter and tropical).

In La Paz, composite flour blends contained soy or soy plus rice or quinoa. In Santa Cruz, soy and rice were tested separately and in combination. Quinoa was omitted because it is not a traditional cereal in the tropical regions. Corn flour had not yet been considered for the project. Details of blend preparations and trials are given in appendix B-18.

La Paz Highlights

These trials confirmed laboratory tests on the usefulness of 20-30 ppm of potassium bromate in conjunction with 0.3% SSL for production of breads from composite flours containing 5 to 15% non-wheat flours. The addition of 5% soy flour enhanced crust color such that the baker associated it favorably with the rich golden brown color of breads containing fat.

Santa Cruz Highlights

The results paralleled those in La Paz with one exception. This was the first commercial trial testing a blend without surfactant-type dough conditioners. Blend #3 (Appendix B-18, page 20) contained 30 ppm potassium bromate in a 10% non-wheat composite flour (5% soy and 5% rice). Marraqueta volumes were only slightly less for this blend than for the baker's 100% wheat flour daily production. Of more concern to the 12 bakers in attendance was the lack of boldness in the break and shred at the cut surface. The same blend with 0.3% SSL and all the other blends tested yielded rolls with very high volumes and bold, appetizing breaks. They crackled in the hand when gentle pressure was applied to the cooled roll.

These bakers suggested additional dough development by hand kneading or by a dough brake (sobadora). Laboratory testing supported this observation that oxidizing agents give maximum effectiveness in well developed doughs. Later commercial trials showed that 5 to 8% of a non-wheat flour could be carried by the wheat with dough strengthening provided only by an oxidizing agent in well developed doughs. When 10% or more non-wheat flour was present, quality was marginal unless a surfactant-type dough conditioner was used to supplement the oxidizing agent.

Comparison

Major differences in bread production and quality criteria in the two locations related to climate as well as altitude e.g., dry and cold in La Paz, hot and and humid in Santa Cruz. La Paz bakers use higher dough absorptions, up to 75% in some locations, to counteract drying effects of atmosphere during mixing and baking. Some Santa Cruz bakers were observed using as little as 50% dough absorption. Baked rolls showed the influence of altitude. With essentially similar doughs into the oven, La Paz doughs expanded more, giving higher volumes especially when dough strenghteners were used. The Santa Cruz products while of good volume had a relatively more compact grain which they preferred in that area.

Final Commercial Bakery Trials, November 1980. In September 1980, composite flours for bakery and pasta trials were produced in a demonstration at the La Inglesa Mill (see Section L). Several sacks of the appropriate blends for baking were shipped to the three demonstration cities as follows:

BLEND	LA PAZ	SANTA CRUZ	COCHABAMBA
8% Quinoa	X		
5% Soy	X	X	X
5% Soy/5% Corn	X	X	X

The principal objective of these trials was to demonstrate the functionality of composite flours for producing marraquetas in mechanized and in artisan bakeries. The three locations chosen represented three different altitudes and climates and a range of baking conditions. All were large cities which had active bakers' associations. The demonstrations served to introduce the composite flour concept and its technology to the several local bakers who attended the demonstrations each day. Their presence and interest provided a keen interchange of ideas with DGNT and WRRC scientists.

Prior to bakery trials, the blends were analysed for ascorbic acid and test-baked at the DGNT laboratory. Proximate analyses were determined at WRRC.

BLEND	MOISTURE %	PROTEIN[a] % (DRY BASIS)	ASH % (DRY BASIS)	ASCORBIC ACID PPM	BREAD
100% wheat flour	11.95	13.96	0.68	0	Excellent
5% soy	11.36	16.82[b]	1.21[b]	100	Excellent
5% soy/5% corn	11.33	15.16	1.18	119	Fair
8% quinoa	11.33	13.78	0.80	20	Poor

a. Nitrogen X 6.25
b. These values would indicate that soy flour addition was between 5.7 and 6.0%.

The ascorbic acid (AA) determination indicated the required 100 ppm was present in the soy and the corn/soy blends but only 20 ppm was in the quinoa blend. Upon inquiry we learned that the quinoa blend was the first produced and before the ascorbic acid feeder was operating properly. Baking tests in the laboratory confirmed the AA deficiency and its correction with 80 to 100 ppm added to the

flour at dough mixing time. Laboratory baking results were excellent for the 5% soy blend, but only fair for the 5% corn/5% soy blend which was significantly improved with 0.2% SSL. To provide for its inclusion in tests, packets of 46 g of SSL, sufficient for 1/2 quintal batches were prepared for adding at the mixer. Since the quinoa blend was demonstrated only in La Paz, the necessary ascorbic acid addition was blended with a portion of the composite flour in the laboratory, then mixed with the remainder of the test sample in the bakery.

To provide continuity in the daily production of composite flour breads, a baker from an artisan shop in La Paz was hired to accompany the team members in all three cities. He was responsible for organizing the ingredients, dough make-up, oven scheduling and baking. On the first day in each city, the team conducted preliminary baking tests without the local bakers present to acquaint themselves with and to determine optimum baking conditions in each situation. The major adjustment was water. In general, the La Paz baker, accustomed to a dry climate, tended to use more absorption water than the bakers in tropical Santa Cruz. Absorption was decreased after initial trials. The blends varied in absorption as follows:

5% soy	53 to 70% water
5% corn/5% soy	65 to 76%
8% quinoa	60 to 66%

In the tests, the formulas of the local bakers were adopted. The following are the ranges used for each ingredient in each location. These percentages are estimated, since no precise measurements were possible with the flour and water.

	La Paz	Santa Cruz	Cochabamba
Flour Blend	5 to 25 Kg	5 to 23 Kg	23 Kg
Yeast	0.5 to 2% Fresh Compressed	0.22 to 0.5% Active Dry	0.65 to 1.1% Active Dry
Sugar	2.0%	2 to 2.2%	0.6 to 6.5%
Salt	0.5 to 1.6%	1.0 to 1.6%	1.1 to 1.5%
Water	60 to 76%	60 to 76%	53 to 70%

As mentioned earlier, all blends contained 100 ppm ascorbic acid. The dough conditioner, SSL, was added at the bakery to some of the 5% corn/5% soy blends. With few exceptions, the baking results were excellent. The marraquetas were equal to the locally produced rolls in respect to dough handling characteristics, bread volume and general appearance. The internal color was always darker with soy and corn and slightly lighter with the quinoa. The main exception to good quality was the 5% corn/5% soy blend when it was baked without SSL. This

blend not only had a 10% dilution of the wheat flour with the non-wheat flours, but also carried 5 to 6% more water due to the extra absorption demanded by the pregelatinized corn flour. Trials with SSL indicated that the 0.2% level was sufficient to overcome most of the problems.

From the flavor standpoint, all breads were acceptable. Bakers could detect quinoa but did not object. They could not detect soy or corn flavors. Some noted preferences for more or less sugar or salt, but no off-flavors were noted.

Between 15 to 30 local bakers attended each demonstration. Always included was the president of the local Bakers' Association in the demonstration city. The National President of the Bolivian Bakers' Association, Sr. Severo Lucana, traveled with the team to each city. At each bakery, he introduced the team and explained the demonstration process. A DGNT scientist then explained the project and the details of the day's work.

La Paz Trials

The first of the final trials were held in a fully mechanized bakery at the Fleischmann's Baking School located in Industrias Venado, S.A., the yeast company in La Paz (12,000 feet elevation). Trials followed in two artisan shops, one in La Paz and the other in the altiplano suburbs at 13,000 feet elevation. The locations and blends tested were:

	Mechanized	Artisan	
		1	2
8% quinoa, 92% wheat	X	X	X
5% soy, 95% wheat	X	X	
5% corn, 5% soy, 90% wheat			X

The visiting bakers could detect the quinoa odor and flavor but did not object. Quinoa is a familiar food in this locality. They could not detect the soy flour in the 5% soy blend, commenting it was similar to their 100% wheat flour bread. It should be noted that this lot of soy flour was darker than lots previously used and might have contributed noticeable color to the product. However, at this point in time, the bakers were receiving very high extraction flour from the mills, thus were becoming accustomed to off-white crumb, which was not unduly changed by the soy.

In the mechanized shop, doughs were developed with a dough brake after fermentation, or with a Hobart-type mixer equipped with a dough hook. Excellent products were obtained. In the first artisan shop, the lack of dough development was

reflected in products with rough crust appearance, some irregular shapes, and lack of boldness in the break and shred. Otherwise, volumes were similar to the bakers 100% wheat breads.

In the second artisan shop, a portion of the 5% corn/5% soy blend was hand-kneaded after 2-1/2 hours fermentation. This blend gave reasonably good bread volumes without kneading; they were markedly improved with the 10 minutes of hand-kneading demonstrating the increased effectiveness of the SSL with dough development.

This was the first commercial test with a blend containing the pregelatinized corn flour. Dough absorption determined by the baker was 6 to 12% higher than for the 5% soy or 8% quinoa blends, thus creating an additional demand on the carrying capacity of the wheat flour. These doughs were softer and later trials without SSL showed the need for the surfactant type dough conditioner. While the corn/soy bread volumes and appearance were acceptable to these bakers, they expressed concern with the heavy scaling weight of dough necessary to compensate for the water loss during baking and cooling. Generally the bakers in La Paz and other high altitude cities add considerably more water during dough mixing to counteract the high evaporation losses occurring at every stage of the process. One baker estimated that a marraqueta scaled to provide 75 g baked bread would lose approximately 20 g water in the oven, 5 grams during cooling and 8 grams during selling. The legal minimum baked weight for this price controlled bread does not have a moisture requirement.

Santa Cruz Trials

The artisan and the mechanized bakeries were both located within the city of Santa Cruz at 1350 feet elevation. The 5% soy and the 5% corn/5% soy blends were tested. DGNT scientists made the decision to test these blends without SSL or any other surfactant additive. During the previous year, the Santa Cruz bakers had seen successful demonstrations of the effectiveness of these additives. On the first day in preliminary trials, using artisan methods and 5 Kg batches, the corn/soy blend was tested with and without SSL. A few visiting bakers did note the effectiveness of the SSL.

Active dry yeast is used in Santa Cruz. It is started in a portion of the water, with some sugar and/or flour added, for about 15 minutes before mixing with the other ingredients.

In the artisan bakery, the 5% soy blend had good volume but the 5% corn/5% soy blend gave less volume than typical for this shop with their 100% wheat flours. This reflected the lack of dough development and the absence of SSL, the surfactant dough improver. Color and flavor were quite acceptable to the bakers.

In the mechanized bakery, an open bowl artofex-type mixer (Pensotti) was used for both doughs. Some development occurred which was supplemented by a dough brake after 2-1/4 hours fermentation. The 5% soy blend was judged by the bakers to have acceptable volume and color with bold breaks, whereas the 5% corn/5% soy blend gave less than the standard volume for this shop and less bold breaks.

In both trials in Santa Cruz, the lack of a suitable dough conditioner was reflected in the poorer baked volumes and cut appearance of the breads made from the 5% corn/5% soy blend. As in La Paz, the higher dough absorption with the pregelatinized corn flour in the blend was of concern because it created heavier crumb in the breads. Evaporation losses were not a problem in this humid climate.

Cochabamba Trials

Only one bakery was used in Cochabamba. It was located in the city at an altitude of about 8000 feet and was a mechanized shop. On the first day, all the equipment was used to achieve maximum dough development. On the second day, doughs were mechanically mixed with subsequent processing by hand to simulate an artisan shop. The 5% soy and the 5% corn/5% soy blends were both tested each day. The corn/soy blend was baked with and without SSL, providing an excellent opportunity to demonostrate the need for and effectiveness of this type of dough conditioner to a group of bakers who had not been previously introduced to the composite flour concept.

Mechanized Procedure: All doughs (23 Kg flour basis) were mixed in a large open bowl, German mixer having an arm that was stationary during blending of ingredients, then moved up and down, folding the rotating dough onto itself. Some development occurred which was supplemented by a dough brake after 2 to 2-1/2 hours fermentation. Doughs were hand scaled and molded, proofed and baked in a metal hearth oven, directly on the hearth and also on trays.

The best volume, color and boldness of break was obtained with the 5% corn/ 5% soy blend containing SSL. Bakers were impressed with the contrast for the same blend baked without SSL. The 5% soy blend (without SSL) has good volume equal to this shop's standard wheat bread. However, the surface breaks were lacking boldness, possibly due to an extremely low absorption (53%) compared to 65% used the second day with more success.

Artisan Procedure: The dough brake was eliminated to minimize development, otherwise the procedure was as described above. Absorption was about 65% for the 5% soy blend and 70% for the corn/soy blend which also contained SSL based on the previous day's success. Both products were excellent. Bakers were impressed with overall results, with bread volumes, color and general appearance of the marraquetas with the dough conditioners.

These Cochabamba bakers main concern, which reflected that of all the Bolivian bakers, related to a constant supply of good quality flour with the proper levels of non-wheat flours and dough improvers. Because they are closer to the customers complaints, they feel they inherit the millers problems and must correct for any lack of quality control on the millers part.

Summary. At this point, the Bolivian bakers appear ready to accept composite flours and new dough improvers such as ascorbic acid and SSL. They already have access to AA. Small samples of SSL, left from the baking tests, were given to those interested in further trials in their own bakeries.

Successful marketing practices for SSL and other surfactant dough improvers should include a distribution center in La Paz rather than in the tropical cities. Research at WRRC has shown deterioration of functional properties in some surfactants when stored at high temperature and high humidity. Part of this is due to chemical breakdown, and part to caking of the lipid-like substance, so it is not easily dispersible.

Bolivian bakers chief concern seems to be with the wheat flour quality and the high extraction level currently being milled. While they fear further dilution of already weak flours with non-wheat flours, the demonstrations showed that dough improvers can overcome these problems. Some now see the Composite Flour Project as the channel by which the government can control the quality of the flour being milled.

In December 1979, the Bolivian government raised the legal maximum extraction rate of flour from 72% to 76% which resulted in a significantly darker flour and, more important to the baker, a weaker flour. From chemical analysis of flours and observations on color of flour and bread crumbs, it appears some mills might be producing up to 80% extraction flours. These have a higher nutritional content in terms of increased vitamins from the bran and germ. However, for the baker, they represent poor quality flours with dark crumb characteristics.

Successful implementation of this project will depend on strong quality control measures to insure good baking flours. In addition soy flour color must be improved to provide a lighter product.

O. Planning for Implementation

Efforts by WRRC to initiate planning began in December 1979. A discussion document was presented to the DGNT in February 1980. It was then expanded and modified according to the February discussion and additional discussions with DGNT in April 1980. Formation of an Interagency Composite Flour Policy Committee with a high government official as convening and presiding chairman was visualized as the mechanism by which certain decisions could be made and through which subcommittees could be appointed to work out details and prepare the plans on the diverse activities of the program. Appendix B-19 is an information packet for use in orientation of the Policy Committee. It provided: 1) Proposed agenda for three meetings of the Policy Committee, 2) Objectives of the composite flour program, 3) Tasks accomplished to date, (4 Tasks remaining, 5) Proposed format of the implementation plan, 6) Diagrams of proposed product flow, billing and payments, 7) Actions required to implement a composite flour program, and 8) Outline of tasks for the Interagency Composite Flour Policy Committee.

While WRRC foresaw a higher level government official as chairman of the Policy Committee, Ing. Bernal, Director, DGNT chose that job for himself, a decision that basically meant a continuation of the project in the narrower confines of the DGNT, a situation that WRRC was trying to break out of. The effort to broaden the base of the project was unsuccessful.

The first and only meeting of the Policy Committee was held April 28, 1980. Attendance was by invitation to the heads of all interested parties. Participation came from MACA, MINPLAN, Ministry of Health, other MICT agencies, Millers' Association, Bakers' Association, PAM-CORDECRUZ (corn processor), CBF (government corporation operating a soy processing plant), Farmers Association of Santa Cruz and WRRC/USAID. The meeting proved to be informational for the participants, but no working relationships were established. The responsibility for preparing the implementation plan remained completely a DGNT task. The exercise of preparing for the meeting did have the positive aspects of consolidating progress to date, looking to the future and setting out new plans to complete the remaining tasks that had been identified (Appendix B-19).

The flow of products, billings and payments for a composite flour program (Figure 4), proposed in the spring of 1980, was based on the facts that the GOB imports and owns all wheat products until sold to consumers (millers are paid a milling fee), and that the GOB was subsidizing wheat flour and generally controlling most prices. Thus Figure 4 shows a GOB agency intimately involved in pruchases, payments and billings for non-wheat flours. This allowed the GOB to retain control of prices and costs and also to have a precise knowledge of composite flour compliance.

On July 17, 1980, General Meza took control of the government in a military coup and on January 10, 1981 most subsidies were eliminated and it was announced that Bolivia would move toward freer markets. Wheat flour subsidized at \$b 300/qq (\$US 12/qq) before the change rose near to the new ceiling price of \$b 610.92/qq (\$US 24.44/qq) when the subsidy was removed. The approach to a composite flour program also needed to be reconsidered in light of a freer

market. In particular, a GOB accounts department, described in Figure 4, would not be needed. The military coup also caused the vitamin/mineral enrichment aspect to be cancelled because of the withdrawl of much of the U.S. economic aid (see Section V.A.)

By mid-January 1981, most of the planned activities such as the demonstration mill and commercial baking tests had been completed. A Bolivian economist had been hired November 1980 with WRRC financial assistance to prepare cost studies for producing wheat flour, corn flour, an update on soy flour (and quinoa flour if time was available) and to suggest a procedure for estimating a fee to be paid to millers for blending composite flours. The economist proved to be irresponsible and these tasks were not completed. In addition, no decision had been reached on the composite flour formulations to be recommended for implementation. Considering these developments and all information accumulated in the project plus the fact that WRRC involvement would terminate March 31, 1981, WRRC prepared a recommendation for a two phase composite flour implementation.

In the first phase, to be implemented as soon possible, all pasta in Bolivia would be formulated with 10-25% addition of pregelatinized corn flour. As part of the first phase, the GOB in its composite flour decree would also stipulate the fortification of all wheat flour with 5% defatted soy flour after about one year. This stipulation for soy fortification was considered to be the triggering mechanism for SAO to commit the capital investment for the needed equipment to produce edible defatted soy flour. The second phase, then, was the addition of 5% defatted soy flour to all wheat flour at each mill. Figure 5 provides a schematic flow chart of the recommended implementation.

FIGURE 4.

IMPROVING THE NUTRITIONAL QUALITY OF WHEAT FOODS IN BOLIVIA

Flow Diagram for Products, Billing, and Payment

(Before policy decision to move toward freer markets)

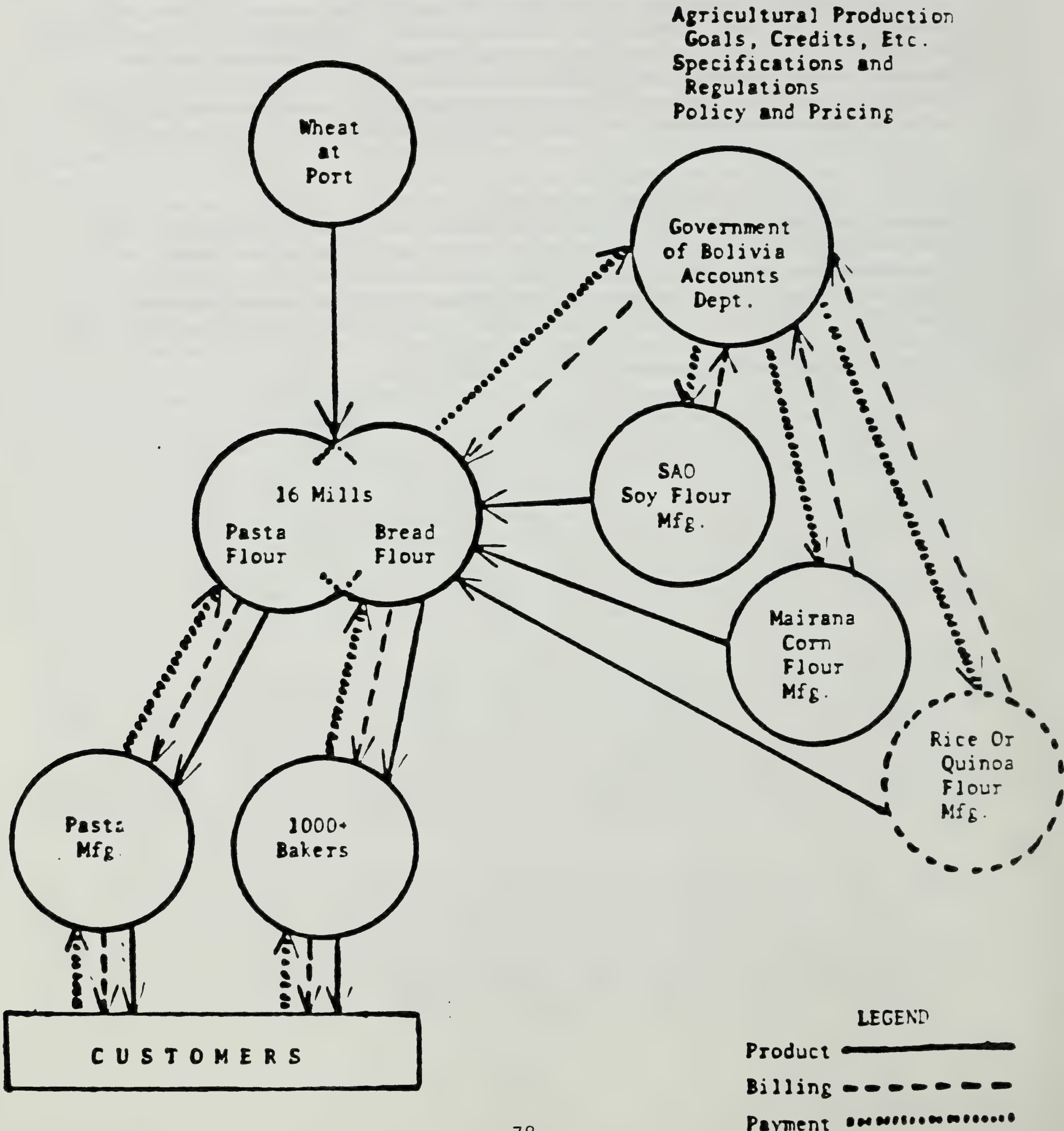
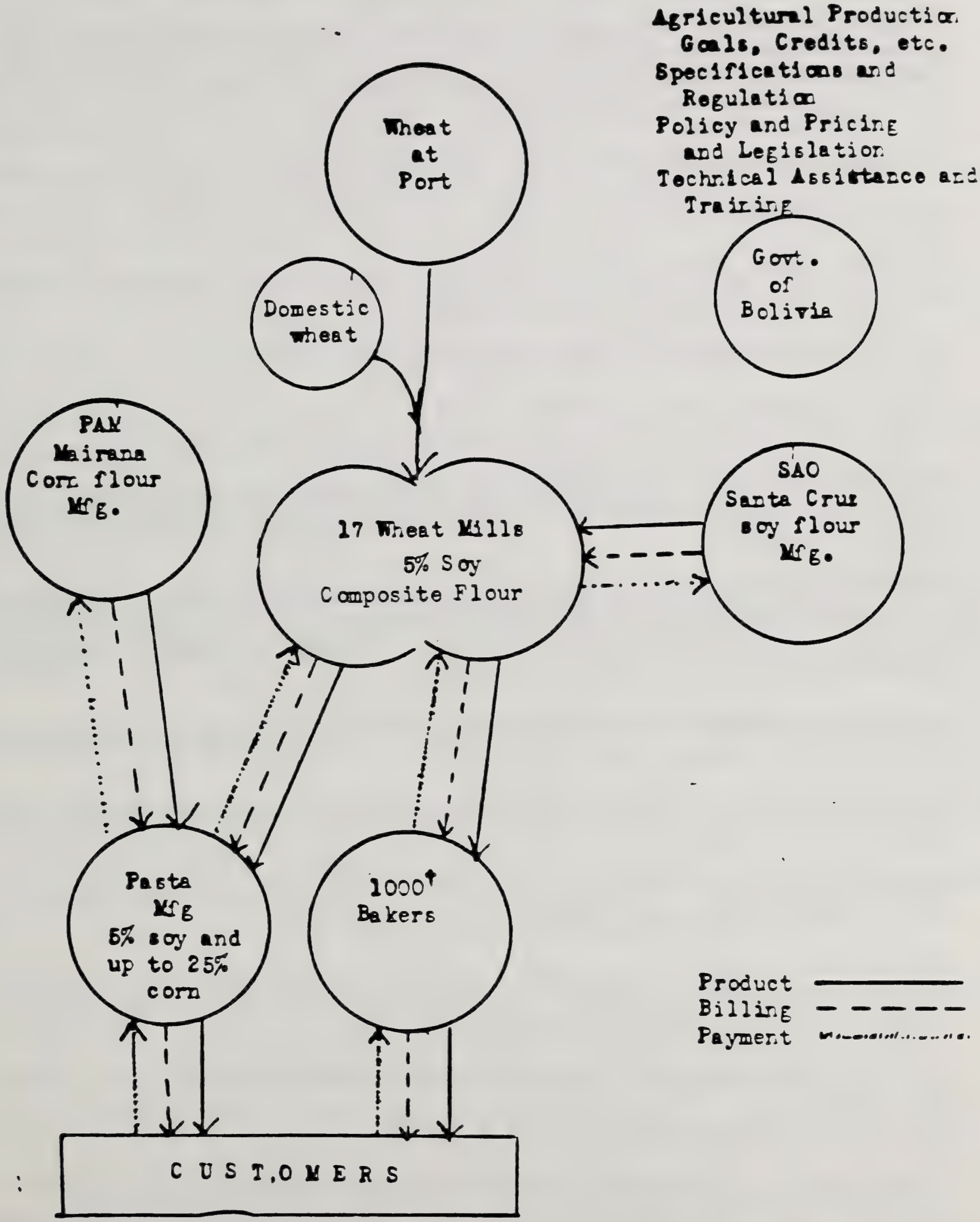


FIGURE 5. COMPOSITE FLOURS IN BOLIVIA

Potential Flow diagram for Products, Billing and Payment
(After GOB policy decision to move toward freer markets)



In support of the plan, the following points are enumerated:

Corn:

1. A recent GOB report noted 200,000 additional hectares available for corn production in the Santa Cruz area (February 5, 1981 quote from Mr. Raul Soria Ruiz, Director General, Interior Commerce). Corn is also produced in the Valles and Yungas.

2. Adequate pregelatinized corn flour production capacity (45 MT flour/24 hrs) is on line at PAM-CORDECRUZ and markets are needed to enhance the financial viability of the unit.

3. The comparative prices of wheat flour and corn flour at February 1981 were $b 600 and $b 482 per quintal, respectively.

4. Corn flour is tradionally less expensive than wheat flour.

5. The CBPI consumer home acceptance tests of 70/25/5 wheat/corn/soy pasta in La Paz, Cochabamba and Santa Cruz indicated very good acceptance.

6. Distribution of 25/75 corn/wheat and 5/5/90 corn/soy/wheat composite flours from the La Inglesa demonstration mill to pasta manufacturers for testing were well received.

7. President Napoleon Pino of the National Pasta Manufacturers' Association was favorably inclined (February 1981) if producers were given flexibility (range of allowable corn flour addition) and adequate financial incentives (no reduction in the $b 920/qq ceiling price for pastas).

8. Some pasta producers are already successfully using pregelatinzed corn flour with no consumer complaints.

9. Pregelatinized corn flour for use in pastas is accepted in Colombia and Venezuela.

10. The use of corn flour at levels up to 25% in pastas does not materially affect protein content or quality.

11. Enchanced corn production is seen as relieving urban migration, especially from the Mairana valley where the PAM-CORDECRUZ corn processing plant is located. Corn is generally a small farmer crop.

12. An average replacement of 15% of the wheat flour by corn flour in pastas would require 6,075 MT corn flour or a reduction of 7,993 MT wheat for an annual import savings of about $US 2,000,000.

13. Implementation of 10-25/90-75 corn/wheat pastas requires no capital investment and is an immediate action that the GOB can take to reduce wheat imports and stimulate domestic agriculture and agribusiness. It pegs the composite flour program as an action program answering real problems and should enchance the chances for adoption of the later soy fortification phases.

Soy.

1. The increasing production of soybeans from 3,400 MT in 1973 to 52,000 MT in 1980 point to the successful cropping of soybeans. The GOB irrigation project "Gran Chaco" is opening as much as 30,000 hectares for oilseeds production in the area of Villamontes in the next few years (Appendix B-6). GOB reports and industry sources have indicated there is substantial unused land in the area of Santa Cruz suitable for soybean production. An adequate supply of soybeans would appear to be assured.

2. Either of two large solvent extraction oilseed plants are suitable for modifiction (estimated cost for SAO is $US 710,000 to 1,035,000, depending on options) to produce a high quality, defatted soy flour. While both companies have indicated a strong interest, officials of SAO at Santa Cruz have, on several occasions, said that they would proceed with the plant modifications if the GOB would issue a decree requiring soy addition and provide controls on wheat millers to assure the correct useage level for soy fortification.

3. The increased crushing of soybeans to meet demand for defatted soy flour for composite flour would also result in more domestic food oil production and help the GOB achieve its goal of self-sufficiency in food oils and produce an exportable surplus.

4. The addition of 5% defatted soy flour to all wheat flour would increase the average daily per capita consumption of protein by 2.3 grams making a signifcant contribution toward reaching the GOB national goal of 56 grams per day.

5. The amino acid score for 5% soy-fortified bread is 52 compared with only 39 for 100% wheat bread.

6. While defatted soy flour is not currently available, a price of $b 365.5/qq is estimated based on the following: February 1981 farmer price of $b 295/qq ($US 260/MT) soybeans; $b 272.2/qq ($US 240/MT) soy meal; and data from Apppendix B-7 that indicates a price (1979) for soy flour of highest quality of $b 274.3/qq when soy meal was $b 204.3/qq. The $b 365.5/qq compares highly favorably to the $b 600/qq for wheat flour.

7. The CBPI consumer acceptance study, while showing the 100% wheat flour rolls were preferred, found that 5% soy fortified rolls were acceptable falling at a value of 2.7 on a hedonic scale between "I like" (2.0) and "I like a little" (3.0). The 100% wheat flour rolls had a hedonic value of 2.16.

8. Baking studies have generally indicated that satisfactory rolls can be made at 5% substitution with the aid of ascorbic acid. However, at higher levels of substitution, e.g. 10%, production of satisfactory rolls often requires the use of additional bread improvers such as sodium stearoyl lactylate (SSL) which adds very significantly to cost, a cost that must be paid in foreign exchange.

9. The La Inglesa composite flour mill experiments demonstrated the feasibility of 5% soy flour and 100 ppm ascorbic acid addition to wheat flour under commercial conditions. The one time cost for equipment required for refitting all 17 wheat flour mills to add soy and ascorbic acid is estimated at a modest $US 248,000.

10. National and regional Bakers' Associations cooperated with the study.

11. The President of the Millers' Association was in agreement with 5% soy fortification though opposing the addition of corn flour at the wheat mills.

12. The domestic availability of food grade defatted soy flour would provide for further opportunities in development of infant foods, milk substitutes, and textured vegetable protein.

13. Stimulated soy production can be expected to provide some relieve from urban migration pressures as farm income and work opportunities are improved in the rural farm areas.

14. A 5% replacement of wheat flour with soy flour would require 11,250 MT of soy flour or a reduction in imports of 14,803 MT of wheat at an annual import savings of about $US 3,700,000.

DGNT basically accepted the WRRC recommended plan but suggested the insertion of an intermediate phase where pastas would be fortified at the pasta plants with 5% defatted soy flour before implementing the 5% soy addition at the wheat mills. WRRC agreed to this and thus agreement was reached on a three phase plan.

This three phase plan (I. 10-25% pregelatinized corn flour in all pastas; II. 10-25% pregelatinized corn flour plus 5% defatted soy flour in all pastas; and III. 5% defatted soy flour in all wheat flour added at the 17 wheat mills) was presented to TCNL Aviation Mario Guzman Moreno, Minister, MICT on February 9, 1981. Minister Guzman said he agreed with the plan, and if all things were as stated and in order, he would move quickly to get the plan implemented as soon as the feasibility report and written plan were presented.

P. Results Since WRRC Project Compeletion (March 31, 1981).

Following the last WRRC visit in February 1981, the DGNT undertook the task of completing economic studies, preparing a comprehensive technical and economic feasibility report and detailed implementation plan based on the three phases agreed to.

The GOB formed an Interministerial Committee on the Wheat Problem in July 1981 and requested DGNT to provide the composite flour feasibility report and implementation plan. DGNT agreed to provide these documents September 1, 1981 (not available at WRRC). Obviously, the composite flour plan provides a well studied action option for the committee. A favorable decision by the Committee, subject to veto by the President, would be the triggering mechanism to proceed with putting the plan into action.

FISCAL SUMMARY

June 1976 - March 1981

WRRC and ESCS salaries and benefits, 7 people	$US 329,000
Location support, WRRC	101,000
SEA and OICD overhead	75,000
WRRC and ESCS travel and per diem[1]	87,000
Contracts in the United States including travel [2]	23,000
Contracts in Bolivia	20,000
Equipment and shipping costs: Bolivian bakery laboratory and feeders for composite flour mill	27,000
Supplies and services in Bolivia	30,000
	$US 605,000

1. 27 person trips to Bolivia, 5 person trips to Costa Rica, 3 person trips to Bolivia and Paraquay, 3 person trips to Sri Lanka, Egypt and Morocco, 13 trips within the U.S., 1 trip to Ecuador.
2. 4 trips to Bolivia.

Appendix A-1

POTENTIAL FOR PROTEIN FORTIFICATION AND EXTENSION OF WHEAT FOODS IN COSTA RICA

Report of Assessment trip to Costa Rica
October 16-30, 1976

Project: Improving Nutritive Value
of Wheat Foods

Conducted under WRRC-AID PASA Agreement #931-11-560-231-73-3168048

Prepared by D. A. Fellers, Food Technologist, Project Leader
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POTENTIAL FOR PROTEIN FORTIFICATION AND EXTENSION OF WHEAT FOODS IN COSTA RICA

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Appendix A-1

SUMMARY STATEMENTS

1. Protein-Calorie Malnutrition (PCM) is a serious problem in Costa Rica for weaned children (6-36 months) with those in the very sparsely populated rural communities being the most seriously affected. Several surveys have shown that calories are usually more deficient in diets than protein. Problems also exist as to adequacy of iron, iodine, vitamin A and riboflavin.

2. The GOCR is in the second year of implementing a comprehensive, well-funded, integrated nutrition-public health-sanitation program (Social Development and Family Assistance Program -- Asignaciones Familiares) aimed at the most vulnerable and needy groups. A number of government agencies are participating. As part of the program, all children in need between 0 and 12 years of age are to receive 2 free meals each day providing 80% of caloric and 60% of the protein requirements.

3. In 1976, the child feeding programs of the Social Development and Family Assistance Program reached about 25% of the potential target group using over 50% of the special tax revenues available. About 50 products from the commercial market are used including large quantities of dry whole milk. Reduction in number and cost of products, improved stability of products and increased use of domestic commodities are major objectives as the program expands. CITA (Food Research Center, University of Costa Rica, San Jose) has been given major responsibility to recommend and develop products, provide specifications, and assist industry in setting-up production capability.

4. There appears to be an underutilization of the expertise of the food industry for developing products for the Social Development and Family Assistance Program. While industry may submit products for consideration, and some are, explicit guidelines

communicated to the industry describing the needs and requirements of the program appear to be inadequate.

5. Agriculture is the main source of employment (36%; 1973) and income accounting for 22% of the Gross Domestic Product in 1972. Coffee, sugar, bananas, and beef exports accounted for two-thirds of export earnings. The GOCR is aggressively pursuing increased production of rice, corn, sorghum and beans through a price support program and development of transportation, storage and marketing infrastructure. Production has increased dramatically and in the case of rice, a surplus situation was recorded in 1975. Accordingly, composite flour programs are fast becoming meaningful as a way to save foreign exchange (reduction in wheat imports). Stimulation of the agricultural sector is improving the income of farmers and farm workers thus reducing migration to urban areas, a major objective of the government.

6. Annual percapita wheat disappearance is 90 lbs. (1976; all imported). Members of the lower socio-economic groups and those living in rural areas eat less bread than those in higher socio-economic groups or those in urban areas. Bread is produced in 6 large bakeries and in a large number (300-1300; range of estimates) of small bakeries. Pasta consumption is generally more uniform and is on the order of 10 to 15% of all wheat consumed. Galleta, a popular sweet cracker is a low-cost minor wheat product with long shelf life. It appears to have good potential for fortification and use in feeding programs. Alternatively, if it is desirable to reach a broad cross-section of the population the large bakeries produce a wide-range of products for distribution throughout the country. They have the capability of producing high-protein and/or composite flour products, given an adequate supply of high quality ingredients at an economic advantage.

7. Costa Rica's only flour mill is a modern one with daily capacity of 7,500 cwt. Extraction rates are low: 67% for US hard spring wheats and 71% for US Western

white. Four different flour types are produced: bread, durum semolina, durum-common wheat blend, and pastry. Wholesale prices ranged from $14.58/cwt (blend) to $19.67/cwt (semolina). Prices are fixed by the government. Almost all flour is packed in 100 lb. cotton sacks and can be delivered to any location in the country within 24 hours. Quality is very high and is routinely monitored in a well equipped quality control laboratory.

8. Production and processing of soybeans in Costa Rica is being carried out on an experimental basis. Cost projections suggest soy flour prices substantially above wheat flour. The only major source of vegetable protein is black beans which, as whole beans, sell at wholesale for 2.28 colones per lb. compared to bread flour at 1.28 colones per lb. (8.54 colones equals $1.00). Black bean flour is not available. Rice or corn flour, if at prices less than wheat flour, might be used to offset the higher blend costs incurred if wheat flour is fortified with soy. However, neither rice nor corn flours are presently available from domestic sources.

9. The government and members of the yuca constituency are attempting to find means of increasing the utilization of yuca. One attempt being made is to implement extension of wheat flour with yuca flour (3 to 20%). This has been unsuccessful thus far. Because yuca flour is similar in cost to wheat flour, there is little or no economic incentive to use it. The extension of wheat flour could reduce the required wheat grind thus hurting the miller's business if introduced at high levels of substitution. If done gradually, however, allowing yuca production to adjust to increasing demand and allowing population growth to retain the level of wheat grind, little, if any disruption would be experienced by the miller. Yuca addition reduces the protein level in wheat flour, increases the possibility of bakery production problems and may affect product organoleptic characteristics depending on the quality of yuca

flour and level of addition. Analysis of a single sample of currently available yuca flour indicated a high bacterial load and a need for improved sanitation. On the positive side, wheat imports could be reduced and yuca production and processing stimulated. Since yuca is grown where many other crops cannot be, expanded yuca production could enhance total domestic food availability and improve agricultural income and employment.

Appendix A-1

RECOMMENDATIONS

The authors - a nutritionist, a baking technologist, an agricultural economist, and a food technologist - consulted with a number of persons in industry, government and the University of Costa Rica. The following recommendations are the authors' conception of the collective thinking of these persons. In October 1976, when the authors visited Costa Rica, some work was already underway on most of these recommendations. If technical assistance is required for expanding this work or initiating new actions it may be requested of USAID for consideration.

1. In order for the Social Development and Family Assistance Program to effectively reach the most vulnerable group, age 6-36 months, there is need to develop low-cost nutritious infant weaning foods. Because of high humidity and temperatures and because suitable storage areas are limited, especially in the most rural areas, close attention to packaging needs is required.

2. Investigate the feasibility of reducing the costs of the Social Development and Family Assistance Program by meeting some of the protein requirement with low cost vegetable protein supplemented products. Soy fortified pasta and/or galletas would offer several advantages: low-cost, popular food forms, stable, easily prepared, suitable industrial capability to manufacture.

3. Increase the involvement of industry expertise for the development and packaging of products for use in the Social Development and Family Assistance Program. Explicit requirements and guidelines detailing the food needs of the Program might be issued by the Government and made known to the food industry.

4. Low wheat flour extraction rates at the mill provide an opportunity to obtain more wheat food (flour) without additional wheat imports. This could be accomplished by a higher extraction rate (new technology in this area has recently been developed at North Dakota State University) or by recovering low-cost Concentrated Wheat

Protein (CWP) from the residual wheat milling byproducts. CWP is a flour product successfully produced in the U.S. and more similar to whole wheat flour than white flour. It can be used in varying amounts to extend regular flour for bread, pasta and biscuits. Additional uses might be as a sausage binder, or in infant weaning foods or breakfast cereals. Production of CWP would not alter the traditional white flour markets. It is recommended for obtaining greater food recovery from the currently imported wheat.

5. Rice production has increased sharply. Puntilla is very small rice brokens resulting from the milling of rice. Some puntilla enters the bran and is not recovered as such. Some is sold as animal feed; that used as food is low-cost. In the likely event of rice surpluses, new markets both domestic and export will be necessary. The levels of brokens in exported rice compared to domestic rice may well have to be reduced to improve quality, resulting in even more puntilla-like material. It is recommended to explore the technical and economic feasibility of using rice puntilla and rice brokens to prepare rice flour to be used to extend wheat flour for bakery or pasta items.

6. Yuca offers the potential of increased domestic availability of food. It is grown where many other crops cannot be. It is recommended that research and technical assistance be provided to assist yuca growers and processors improve the economics and quality of yuca flour for human food including its use in extending wheat flour.

Appendix A-1

Glossary of Acronyms

AID (USAID)	Agency for International Development
CARE	Cooperative for American Relief Everywhere
CEN	Centro de Educacion y Nutricion
CITA	Centro de Investigaciones en Tecnologia de Alimentos
CNP	Consejo Nacional de Produccion
GOCR	Government of Costa Rica
ICNND	Interdepartmental Committee on Nutrition for National Defense
IMAS	Instituto Mixto Ayuda Social
INCAP	Instituto de Nutricion de Centro America y Panama
INISA	Instituto de Investigación en Salud
MOH	Ministry of Health
PAHO	Pan-American Health Organization
TAICH	Technical Assistance Information Clearing House
USDA	United States Department of Agriculture
WRRC	Western Regional Research Center

INTRODUCTION

Population

The need for a program of protein fortification of wheat foods and its success in reaching population groups that are deficient in protein depends on a number of demographic and socio-economic factors. Among these are the distribution of the population, especially the size and accessibility of the potential target groups.

In 1973 - the year of the most recent national census - the population of Costa Rica was 1,905,338. By the end of 1974 this had increased to an estimated 1,945,594 - a 2 percent increase. The average rate of growth of the population between 1970 and 1974 was 2.6 percent per year.

The country is divided into 7 provinces, 80 cantons, and 409 separate administrative districts. Population is heavily concentrated in the Meseta Central with an estimated one-third of the people living within 20 kilometers of San Jose, the major city and capital. The capital cities of 4 of the 7 provinces are within this 20 kilometer radius. Of the 409 administrative districts, 297, or nearly three-quarters, have populations of under 5,000.

The people live in 4,872 separate communities. Of these, 4,495 - over 90 percent - have less than 1,000 inhabitants. Reportedly, one-third of the population is under the age of 12.

About 60 percent of the population lives in rural areas. Of particular importance is the fact that more than half of these rural residents live in communities of less than 500 inhabitants. These communities generally lack even the most rudimentary services and contain the people who are most in need of nutrition intervention programs but who are the most difficult to reach.

Gross National Product

The gross national product of Costa Rica for 1976 is estimated at U.S. $2 billion. On a per capita basis, this is U.S. $1,091 up from $579 in 1972 and the highest of the five Central American countries. Nevertheless, poverty is widespread throughout the country, especially in the rural areas.

The 1973 census revealed that 35,000 rural families (200,000 people or 10 percent of the population) had per capita incomes of under U.S. $65. The same year, 20 percent of the total population had incomes of under U.S. $150 per capita which is the USAID poverty line.

Importance of Agriculture

Agriculture is the main source of employment and income in Costa Rica. In 1972, 22 percent of the gross domestic product was from agriculture. The major crops are coffee, sugar, bananas, and beef which are all consumed domestically, but the major part of the production of these four crops is exported accounting for two-thirds of Costa Rica's foreign exchange earnings in 1975. Most bananas, sugar, and beef are produced on large farms, whereas coffee, traditionally the largest foreign exchange earner, is a small-farm labor intensive crop. In 1973, 35,353 farms reported production of coffee. Eighty-five percent of these were smaller than 3 hectares.

The total active work force in 1973 consisted of 583,313 persons of which about 7.4 percent were unemployed. Currently unemployment is reported to be between 4 and 5 percent. Of the active work force in 1973, about 36 percent was in agriculture where the rate of unemployment was less than 3 percent. Because of the importance of agriculture in the economy, Costa Rica's development policies encourage continued development of agriculture, not only of the traditional export crops but also of basic grains, horticultural

crops, and dairy and pork production for domestic use. The overall goal of this strategy is to improve the quality of rural life and thus avert large-scale migration of rural people to urban areas where they would compound the problems associated with rapid urban growth. A specific goal of the government is self-sufficiency in basic grain production by 1980 (corn, beans, rice, sorghum).

Appendix A-1

NUTRITIONAL STATUS OF THE POPULATION

The major nutritional problem in Costa Rica, as in other Central American countries, is protein-calorie malnutrition (PCM). Also discussed in this section are the adequacy of vitamins and minerals in the diet and aspects of public health.

Protein-Calorie Malnutrition

Anthropometric Analyses -- Extensive surveys conducted in 1966 (INCAP, 1969) and in 1975 (Amador et al.,1975), specific studies of rural areas including Pital de San Carlos, Santa Ana de Belén, Grifo Alto in 1972, San Rámon, Palmichal de Acosta, Colorado de Abangares in 1974 (described in; AID, Dec. 1975), together with a recent survey of 22 Centros de Educacion y Nutricion (CEN) by CARE (Anderson et al., 1976) provide anthropometric data on Costa Rican children from 0-5 years of age. There is also a recent nutrition assessment of Costa Rica (AID, Oct. 1975). Although various sampling techniques were used in 1966 and 1975 to study both the urban and rural sectors, these surveys did not provide data for the estimated 600,000 persons living in villages of less than 500 inhabitants. The 1972 studies were directed toward this segment of the population.

Interpretation of the data is largely dependent upon the growth standards selected. The Gomez/Iowa standards for protein-calorie malnutrition are often used in which weight for age of the population is compared with the standard. Using the Gomez standards, the Ministry of Health (Amador et al., 1975) found a mean of 53% of the children less than 5 yrs of age were suffering from first, second and third degree malnutrition. The values ranged from 43.2-62.5% within the five health regions of Costa Rica. Malnutrition was

invariably higher in the rural than in the urban populations examined. Values as high as 77.6 and 81.5% of the preschool children in Santa Ana de Belén and Grifo Alto were reportedly suffering from the various degrees of malnutrition. There was also little difference reported between the 1966 and the 1975 studies with means of 57% and 53% respectively. The slight differences were the result of a 2% decrease in 1975 for both first and second degree malnutrition.

The high incidence of reported malnutrition and the lack of any significant improvement in status since 1966 have prompted criticism and re-evaluation of the use of the Gomez standards in Costa Rica. Some of the points follow:

1. The Gomez classification scheme is not appropriate for Costa Rican children in terms of birth weight and growth progression.
2. Weight for age standards are insensitive to improvements in height for age (which did improve between 1966 and 1975). Thus, more than one criteria should be used.
3. Those severely retarded in growth for a variety of reasons (including genetic abnormalities) are all classed as third degree malnutrition although the cause was not nutritional deficiency of the child's diet.
4. The Gomez standards indicate that Costa Rican children become more severely malnourished as they grow older (28.3%, less than 2 years; 63.8% for 4 year-olds). This is contrary to observations that children are most malnourished in the first and second years (Mata and Mohs, 1976).

L. Mata, Director of the Instituto de Investigaciones en Salud, University of Costa Rica, has applied the methods described by Waterlow and Rutishauser (1974) to the data of rural Costa Rican children in the 1966 and 1975 surveys. "Stunting" ($<$91% of height for age) decreased in the 0-4 yr. olds from 16.9 (1966) to 7.2% (1975) (Mata and Mohs, 1976). Waterlow and Rutishauser suggest

"stunting" is the result of chronic malnutrition, whereas "wasting" (< 80% weight for height) or combined wasting and stunting are the result of acute malnutrition and/or morbidity. It could take years to correct stunting, if it could indeed, be corrected, whereas, wasting is a more temporary condition and would be expected to respond to nutrition intervention. Dr. Mata suggested that much of the wasting reported in 1975 was a result of the improvement in height, rather than weight loss. Thus, he concluded that malnutrition has decreased since 1966. There are, however, according to Dr. Mata an estimated 25% of the children 0-5 yrs. of age who have deficits in height, weight, or both. Thus malnutrition is still seen as a major health problem.

A recent survey by CARE (Anderson et al., 1976) examined nutritional status using a National Academy of Sciences Reference Population. These standards resulting from a random sampling of populations were based upon the Fels Research Institute Growth Study for 0-24 months, the Preschool Nutrition Survey for 25-59 months and the National Health Examination Survey, Cycle II for 60-143 months. Using these standards the data was examined using either the stunting and wasting criteria or the Gomez classification scheme. The comparative results are shown in Tables 1 and 2.

The differences in the normal populations between these two methods emphasizes the dependence of interpretation upon methodology and standards chosen.

In summary, protein calorie malnutrition exists in Costa Rica and is most prevalent among the rural population. The magnitude and severity of the problem depend upon the method used to evaluate the data. Protein calorie malnutrition has been reported to affect > 50% of the children < 5 yrs. of age when the Gomez classification scheme and Iowa standards are used, and slightly less than 13% within the CEN populations if stunting and

Table 1

Gomez classification. Weight for age by length of participation in CEN program (NAS Reference Population)

Percent of Costa Rican children 12-66 months.

Group	Normal	First Degree	Second Degree	Third Degree	No.
CEN < 6 mons.	44.3	43.7	9.8	2.2	183
CEN > 6 mons.	48.8	42.6	8.6	---	324
Total	47.1	43.0	9.1	0.8	507

Normal = 90% of NAS Reference Weight for age median

First Degree: 75-89.9% of NAS reference weight for age median

Second Degree = 60-74.9% " " " " " " "

Third Degree: < 60% " " " " " " "

Reference: Anderson et al., 1976.

Table 2

Stunting and Wasting by length of participation in CEN Program (NAS Reference Population)

Percent of Costa Rican children 12-66 months.

Group	Normal 1/	Stunting 2/	Wasting 3/	Stunting and Wasting 4/	No.
CEN < 6 mons.	84.7	9.3	4.9	1.1	183
CEN >6 mons.	89.2	8.3	1.9	0.6	324
Total	87.6	8.7	3.0	0.8	507

1/ Normal = ≥80% median weight for height and 90% median height for age.

2/ Stunting =≥80% median weight for height, but < 90% median height for age.

3/ Wasting = <80% median weight for height but ≥ 90% median height for age.

4/ Wasting and Stunting= < 80% median weight for height and <90% median height for age.

Reference: Anderson et al ., 1976

wasting criteria are used with the NAS Reference Population Standards. Stunting and wasting methods are more explicit since they delineate which condition is most prevalent and in greatest need of attention.

Dietary Availability of Calories and Protein -- Although protein deficiency was once assumed to be the major cause of PCM, recent studies have provided evidence to question this conclusion. Valverde et al., (1975) found that the vast majority of the diets were deficient in calories and only a small proportion were adequate in calories, but deficient in protein (Table 3).

Table 3

Analysis of the diets of preschool Costa Rican children in relation to deficiency of protein and calories
(1966 INCAP Study)

	Adequate in Calories	Deficient in Calories	Total
Adequate in Protein	12.8%	43.6%	56.4%
Deficient in Protein	1.3%	42.3%	43.6%
Total	14.1%	85.9%	100.0%
(1974 San Ramon Study)			
Adequate in Protein	24.5%	43.7%	68.2%
Deficient in Protein	0.0%	31.6%	31.8%
Total	24.5%	75.5%	100.0%

Reference: Valverde et al., (1975)

Protein and caloric adequacy of diets were influenced by socioeconomic status of rural Costa Rican preschool age children (Menchu et al., 1973). Within each level, however, calories were consistently more limiting than protein, with protein being adequate in all levels except the low socioeconomic status (Table 4).

Table 4

% Adequacy of diets of rural Costa Rican preschoolers

Nutrient	Socioeconomic Status Low	Medium	High
Calories	64	78	83
Protein	85	121	148

Reference Menchu et al., 1973

Valverde et al., (1975) calculated The Net Dietary Protein Calories Percent (NDpCal%) of the diets of rural Costa Rican preschoolers. NDpCal% = $\frac{\text{protein calories}}{\text{total caloric intake}}$ x 100 x NPU*. The respective values were 10.4% (1 yr.), 9.5% (2 yr.), 9.3% (3 yr.) and 8.8% (4 and 5 yr.). The relative importance of these values is apparent when they are compared with the estimated recommendations of 5.3% (6 mons.), 4.6% (1-3 yrs.) and 4.3% (4-6 yrs.) using Miller and Payne's method (1961) and the provisional amino acid patterns for preschoolers described by FAO (1973).

The CARE survey (Anderson et al., 1976) revealed much the same trends with diets being invariably limiting in calories (Table 5).

Table 5

Dietary intake by 24 hour recall of Costa Rican children (12-66 mons) by number of CEN Meals Consumed

	Calories	Protein (g.)	% INCAP RDA[1/] Calories	Protein	RDA Calorie Gap
No meals at CEN	1033	31.0	59.0	93.9	717
Lunch at CEN	1198	40.0	68.5	123.9	552
Breakfast & Lunch at CEN	1495	53.0	85.4	160.6	255
Total (with and without meals at CEN)	1203	39.7	68.7	120.3	547

1/ INCAP RDA: 1750 calories, 33 g. Protein/day 4-6 yr. old
Reference: Anderson et al., 1976
* NPU = Net Protein Utilization

An analysis of the 1975 MOH Recommended diet for the CEN program showed the diet would provide 959 calories and 39.9 g protein daily (24 g derived from milk and meat) (Anderson et al., 1976). The disproportionate quantity of protein provided has resulted in an expensive program.

Protein quality of the diet, as well as quantity should be examined. Earlier data indicated that 44% of the available protein and 35% of the consumed protein was derived from animal sources (INCAP, 1969). More recently, Menchu et al., (1973) calculated the following proportions of dietary protein obtained from animal sources: 77% (1 yr.), 58-60% (2-3 yr.), 45% (4-5 yr.). The latter data was from rural Costa Rican data. Various studies by INCAP suggest that the sulfur amino acids and not lysine, may be the first limiting amino acid in Costa Rican diets.

Personal comments by individuals such as Mr. Antillon (Vice Minister of Health) who describes the objectives of the 2 meals/day provided by the Asignaciones Familiares program -- "to provide 60% of the protein and 70-80% of the caloric requirement" indicates that government and administrative officials are aware of the need for calorie supplementation of diets. Dr. Mata of INISA suggests that if 80% or more of the caloric requirement is met, the control of infection should be the next priority if a nutritional impact is to be shown.

At present, calories seem to be the most limiting macronutrient in the diets of the lower socioeconomic Costa Ricans. Dietary supplements would most logically provide a larger proportion of the caloric than the protein requirement. High calorie supplements and/or larger quantities of the diet are two methods of approaching the problem. A major problem is that those most in need of dietary supplements (those 6-36 months of age in the more remote rural regions) have not been effectively reached by previous programs. The Government of Costa Rica

recognizes this and has targeted their Asignaciones Familiares program to reach the very remote areas. Stable, nutritious weaning foods would seem to be the most effective dietary supplement for those 6-36 months. Distribution might be bimonthly or monthly to the mothers.

A brief reference to dietary patterns might provide some indication of appropriate food vehicles in supplementation programs. Major caloric sources for the poor are sugar, rice and corn, whereas that of the European population are sugar, rice- and wheat (Flores, INCAP). Wheat was described as a prestige food and consumed mainly by the medium and high income groups. Detailed information on wheat consumption is cited in the section on Wheat and Wheat Foods.

Vitamin and Mineral Status

Although earlier surveys included evaluations of vitamin and mineral status, with the exception of the data of Menchu et al., (1973), more recent surveys have been mainly limited to anthropometric indices and the implications upon PCM. The recent MOH survey (Amador, 1975) attempted to gather data on hemoglobin levels but the methodology employed resulted in samples which were not usable.

The 1966 INCAP survey (INCAP, 1969) reported significant deficiencies in Vitamin A, folate, iron and iodine. It was summarized in PAHO, 1970 (Table 6).

Table 6

Vitamin A serum levels in population less than 15 years of age and in general population*

	ng/100 ml		
	< 10	10-19	< 20
	- - - - % of Population		- - - -
< 15 yrs.	4.0	26.0	30.0
General Pop.	1.6	13.0	14.6

Reference: PAHO, 1970

*Normal range for serum Vitamin A levels, 25-90 ng/100 ml serum.

Folate deficiency was reported in 9% of the urban and 19% of the rural population, whereas 6 and 17% of these populations, respecitvely showed symptoms of iron deficiency (INCAP, 1969). In the early 1970's between 10 and 19% of the general population exhibited endemic goiter (PAHO, 1974). In a recent survey of 148 families selected from all the rural provinces of Costa Rica, iron and niacin were most deficient in the diets of preschoolers, irrespective of socioeconomic status (Table 7). Niacin values may be unrealistically low,

Table 7

% Adequacy of the diets of rural preschoolers in Costa Rica

Nutrient	Socioeconomic Level Low	Medium	High
Calcium	93	159	240
Iron	43	52	48
Vitamin A	43	87	118
Thiamine	72	98	106
Riboflavin	86	141	211
Niacin[1]	37	49	46
Vitamin C	38	75	110

1/ Does not include Niacin derived from Tryptophan.

Reference: Menchu et al., 1973.

however, due to methods of calculations used. Vitamin C and Vitamin A varied with socioeonomic level, being lowest in the poor.

Various fortification and supplementation programs including iodization of salt (1972), Vitamin A fortification of sugar (1975) and compulsory fortification of all wheat flour with thiamine

(4.5 - 5.5 mg/kg), riboflavin (2.6-3.3 mg/kg), niacin (35-44 mg/kg), iron (26-36 mg/kg), and Calcium (1.1-1.4 g/kg) have been implemented (PAHO, 1972). Although expected to have some impact, with the exception of Vitamin A and iodine, fortification programs should not be expected to alleviate all vitamin and mineral deficiencies. In a recent assessment document, thiamine, riboflavin and Vitamin A deficiencies were identified as being significant (AID, Dec. 1975). Dr. Osuna (PAHO) also considers Vitamin A and riboflavin deficiency to be of importance, and includes iodine and fluorine as well. The interaction and interdependence of various nutrients during absorption and metabolism need to be considered when supplementation of diets with a select nutrient or nutrients is considered.

Public Health Status

Public health indices are an indirect indication of nutritional status and favorable public health programs are imperative if a nutritional impact via fortification is to be obtained. By nearly all public health standards, Costa Rica has improved markedly in the past decade. This may, provide additional evidence for questioning the conclusion of virtually no nutritional improvement reached when using the Gomez/Iowa scheme.

According to the 1973 census, 26-50% of the population in the five health regions had septic tanks, whereas 14-42% had concrete slab latrines. Only 5-25% between the five regions had no sanitary service. Water systems are common among Costa Ricans with 22-90% having public and 3-31% having private systems within the regions.

A recent report summarized the decrease in infant mortality and deaths by disease during the last decade (Mata and Mohs, 1976). Infant (0-11 months) deaths/1,000 live births decreased from 76 in 1965 to 37.6 in 1974. Deaths

from diseases which are preventable by vaccination also decreased markedly from 590 in 1965 to 144 in 1974. Although there was this improvement in health status, an AID report (AID, 1975) maintains that from 39-60% of the remaining deaths (0-5 yrs.) in the five health regions are due to malnutrition and poor sanitation. Principal causes of death were enteritis and diarrhea, infectious diseases and parasites, and pneumonia.

Improvements have been made in public health during the past decade. With the current emphasis of the Asignaciones Familiares program upon public health sanitation and nutrition the impact of a nutrition intervention program would be enhanced.

GOVERNMENT NUTRITIONAL POLICY AND PROGRAMS

Introduction

The Government of Costa Rica (GOCR) is actively involved and supportive of nutrition programs. President Oduber included the alleviation of malnutrition in his campaign platform. His goals were to feed every child in need and use indigenous sources.

The National Nutrition Program obtains resources from the Social Development and Family Assistance Law. The GOCR chose nutritional improvement as one of the major methods of improving the well being of the poor. The program, discussed further in Distribution and Retailing System for Wheat Foods, consists of feeding well balanced meals to vulnerable groups, improvement of rural water and sanitation systems, and preventative health care.

Social Development and Family Assistance Law

The Social Development and Family Assistance Law (Dirrecion Asignaciones Familiares) provides for a general payroll tax to support its programs which include feeding, health, sanitation, housing, land and old age assistance programs. An official of the program indicated recent fund uses of 75% for health and nutrition elements and 20% for old age assistance.

Although initially a means of supplementing income, this law has become a method of income distribution by providing various services to defined marginal sectors of the population. Nutrition was identified as a problem of the poor and various target groups were defined within the "Health, Food and Nutrition" portion of the program as follows.

1. Feeding Programs
   a. Preschoolers, pregnant and lactating women: provide two meals/day to all urban and rural communities (including those with $<$ 500).

b. School programs: urban and rural communities selected on the basis of low income, poor sanitation, lack of public health services (includes nearly all of the rural schools).

2. Environmental Sanitation

Marginal populations in communities of $<$ 500. Includes programs on water systems, latrines, improvement of sanitation within the home.

3. Preventative Health Care

Rural communities of $<$2000.

One of the major objectives of the program is to reach the more remote segments of the population living in communities of $<$500 inhabitants. There are approximately 650,000 in such communities - accounting for nearly 35% of the population. The program is a very dynamic one, and revisions are continually being made. Various aspects of the program are described in this report under "Distribution and Retailing System for Wheat Foods", and in the AID Nutrition Assessment (AID, Oct. 1975).

These activities, administered by Asignaciones Familiares through the MOH are part of a complex and integrated program. Many agencies and resource groups are involved including Ministry of Labor and Resources, Instituto Mixto Ayuda Social (IMAS), Consejo Nacional de Produccion (CNP), and institutes at the University of Costa Rica such as CITA (Food Research Center), and INISA (Health Research Center) and PAHO who are working on standards for food products and evaluation of nutritional impact. PAHO and MOH personnel are using morbidity and mortality data to evaluate the first stage of the food distribution program, i.e. the distribution of milk. Initial distribution of food began in mid 1975. Nearly 150,000 have been reached by the program with a goal of 500,000-600,000 by 1980.

Food products used in this program are selected by criteria such as nutritional value, cost, stability, ease of preparation by the consumer, use of indigenous products and ease of transportation. Initially some 50 to 60 products available on the commercial market were used. The philosophy was to use foods which were not prepared specifically for the poor. One of the suggested reasons for the limited success of INCAPARINA in Costa Rica was the stigma attached to a food designed for the poor.

The GOCR has decided to decrease the number of products, and Dr. F. Arias and staff at CITA have been charged with developing standards for products which will be submitted to the MOH who has final responsibility. Asignaciones Familiares and the MOH ultimately decide who will manufacture the products, and expect to award one-year contracts to those selected.

Milk was one of the first products distributed on a large scale. Production has kept pace with demands, but it is anticipated that either a milk extender or replacer will be needed to fill the demands in the future. CITA has been exploring the use of rice, soy, corn, and other commodities as milk extenders.

Perishable, expensive products are not likely to reach the most remote areas. Thus, animal protein in the form of salami and sausages are more appropriate. Dehydrated fruits and vegetables, as well as beans, rice and corn have merit. Within wheat products, pasta was most often suggested as an appropriate vehicle due to stability and ease of preparation, and high degree of acceptability among Costa Ricans, AID personnel suggested that bread was not eaten in the more remote areas due to lack of bakeries. Tortillas are most often consumed. Fish products are being explored and CITA is working on a drum dried mixture of bananas, rice and soy.

The Social Development and Family Assistance programs are planned to be comprehensive and provide for the integration of nutrition with public health

and sanitation programs. Any additional nutrition intervention program would be more likely to show an impact under these conditions and, thus, would be a favorable environment for such programs.

Voluntary Agencies

by Technical Assistance Information Clearing House

According to a recent publication/ (TAICH, 1974), there are a number of voluntary agencies in Costa Rica including CARE, Catholic Relief Services, Church World Service, National Council of Churches, Mennonite Economic Development Service, Kellogg and Rockefeller Foundations, and others. This discussion will be limited to the activities of CARE.

CARE has a very active program under the leadership of Kurt Bachmann, director. There are nearly 300 Centros de Educacion y Nutricion (CEN) which serve the needs of preschoolers, pregnant and lactating women. These are built through the cooperative efforts of CARE, The Ministry of Public Works and Transportation, and the local community which provides the site and some local materials. A specific CEN visited at Itiquis was described as typical by CARE personnel. An estimated 70 preschool children, 3 to 5 years 11 months, were using the center. This accounted for approximately 28% of the villages' nearly 250 preschool children. Since the children must walk to the center, those in the more remote areas are not reached. Children remain at the center from 7:30 - 12:30 receiving both breakfast and lunch. Those 4 yr. 11 months to 5 yr. 11 months receive instruction between meals. The menu included milk, tortilla and papaya for breakfast; meat, potatoes, black beans, salad, fruit and aqua dulce for lunch. The diet seemed high in protein, especially animal protein. The cook found many uses for CSM, but fewer for WSB, this being used mainly for the gruel, atole.

The impact of CEN upon diets of participants was described earlier under "Dietary Availability of Calories and Protein."

CARE is also actively involved in the exploration and development of soybean production in Costa Rica in cooperation with IMAS and AID. This is further discussed in this report in the section "Protein Sources".

WHEAT AND WHEAT FOODS

Wheat Supply

If protein nutriture is to be achieved through addition of protein to wheat foods, development of a successful program will depend to a certain extent on the sources of wheat, price structures, government policies and costs. These topics are discussed in this section.

No wheat is grown in Costa Rica on a commercial basis. All requirements for wheat are met with imports, mainly from the United States. Imports of wheat for 1975-76 were estimated at 80,000 metric tons (MT) or 1.4 percent above the previous year. Imports for 1976-77 are forecast at 90,000 MT. Small quantities of wheat flour also are imported. There are no duties on wheat imports but the import duty on flour is set at a high level to encourage local milling.

The price of wheat imported by Costa Rica varies with the world price. In October 1976 the import price for wheat from the Pacific Northwest c.i.f. at the port of Puntarenas was $190 per MT. The only other cost would be rail freight from Puntarenas to Alajuela, the location of the only flour mill in Costa Rica. Storage capacity at this mill is 25,000 MT but when the price is favorable, contracts for future delivery are made for much larger quantities, thus resulting in much more stable prices to consumers than would otherwise be possible.

Consumption of Wheat Foods

Consumption of wheat foods in Costa Rica on a per capita basis is higher than in any of the other Central American countries. For the past 10 years, ending in 1975-76, total wheat consumption has been averaging around 73,000 MT per year with somewhat lower consumption during high-priced years and somewhat higher consumption during low-priced years.

The most recent estimate of consumption for wheat in 1975-76 is 80,000 MT. This is an increase of 11 percent over the previous year and is reportedly due to increasing consumer demand as well as to lower prices for flour. Consumption of wheat in 1976-77 is forecast at 85,000 MT. On a per capita basis, the 1975-76 consumption would be equal to about 90 pounds of wheat. At the average reported extraction rate of 67 percent, this would be equivalent to about 60 pounds of flour per person.

The extraction of flour from wheat is so low reportedly because the people in Costa Rica consider wheat foods - particularly white bread - as status foods. In Guatemala, the extraction rate is reported to be 80 percent for most flour and in the United States white flour is mostly of 76 percent extraction. Costa Rica could presumably save considerably on foreign exchange, reduce flour costs and improve the nutritive value of wheat foods if a higher extraction flour could be made acceptable to the people.

Consumption of wheat is mainly in the form of commercially produced bread and other bakery products. About 78 percent of the flour is first patent (primera patente) which is used for bread, cakes, sweet goods, and other bakery products.

Another 15 percent of total flour production is semolina flour of different types which is used in the commercial production of pastas. One special type of flour (Corona) used for pasta manufacture is made from 60 percent DHW and 40 percent amber durum.(durum ambarina). The government pricing structure on this flour results in a subsidized price for pastas made from this flour and thus encourages its consumption by lower income groups. Another type of flour (suave) is used for manufacture of crackers / and pastry goods. Only about 3 percent of all flour milled is packaged for home use. Flours are discussed on pg. 28-30.

To plan a program of protein fortification of wheat foods that will reach the desired target groups through regular commercial channels, the consumption

of wheat foods by these target groups must be evaluated. The information on the consumption of wheat foods in Costa Rica by age, income, and urbanization is rather sketchy. Available data is from a 1966 survey by INCAP which included 4,065 individuals from 30 cantons selected from all 7 provinces throughout the country. Although not up to date, this survey shows a much larger consumption of bread than other wheat products in Costa Rica and much larger consumption in urban than in rural areas (Table 8).

Table 8

Average weekly per capita consumption of wheat foods by urbanization, Costa Rica, 1966

Wheat food	Urbanization		
	Urban	Rural	Dispersed
	- Grams per person per week -		
Bread	493	235	59
Pastas	47	41	4
Galletas y Tostellas	6	19	0

Source: Dr. Carlos Diaz Amador, Ministry of Health

The same study shows the average daily per capita consumption of wheat foods in the rural sector by low, medium, and high socio-economic groups. The sample on which this analysis was based included only 148 families from the 30 sample cantons. Consumption was obtained during 3 consecutive days by recording the intake levels of different foods.

In addition to average per capita intake for families, the intake of 78 preschool children from these families was estimated separately. The daily consumption of wheat foods by these two groups and by the three socio-economic groups - classified on the basis of an index of 8 socio-economic indicators - is shown in Table 9. These data show a much higher consumption of bread than of

pasta for all groups. They also show that average consumption of bread for all family members was significantly higher for the high and medium groups. For preschool children, the consumption of bread was more uniform between socio-economic groups.

Table 9

Average weekly per capita consumption of wheat foods by rural families and preschool children from different socio-economic levels, Costa Rica, 1966

Group and wheat food	Socio-economic group		
	Low	Medium	High
	- Grams per person per whek -		
All family members			
Bread	245	357	518
Pastas	49	77	56
Preschool children			
Bread	168	245	175
Pastas	28	28	21

Source: Menchu et al. (1973).

In addition to the 1966 INCAP study, in 1975 the Ministry of Health of Costa Rica made a nutrition survey the primary objective of which was to evaluate the nutritional status of children under 5. The sample for this survey was selected from 41 cantons. Of these, 30 corresponded to the same cantons that were used in the 1966 INCAP study. The 41 cantons were selected from 5 "health regions" corresponding to the different regions of the country as follows: Region 1, Centro; region 2, Norte; region 3, Pacifico Seco; region 4, Atlantico; and region 5, Pacifico Sur (see map in Appendix). Food consumption patterns of the families sampled were recorded. Among other things, these consumption patterns showed the use of wheat foods by people in the different health regions and are summarized in Table 10. These data show that bread is eaten more

frequently than other wheat food, but there is a wide variation among regions. In region 3, for example, only 48.3 percent of the people ate bread daily for breakfast, while in region 4, 83.8 percent did so. The quantities eaten were not specified, nor were the reasons for the differences, which could be due to economic factors, food preferences, or differences in availability.

Table 10

Percentage of people consuming different wheat foods daily at different meals, for the 5 health regions and for the entire country, Costa Rica, 1975

Wheat food and meal	Health region 1	2	3	4	5	Entire country
	- - - - - percent - - - - -					
Bread						
Breakfast	80.7	63.9	48.3	83.8	56.8	67.7
Morning break	12.7	13.0	2.3	8.7	2.9	8.9
Afternoon break	72.3	70.9	41.0	67.0	56.1	64.4
Pastas						
Lunch	14.2	16.9	7.8	15.4	7.0	13.5
Dinner	13.9	19.7	5.6	17.9	10.9	14.7
Galletas						
Afternoon break	3.2	2.8	3.1	10.2	9.2	4.9

Source: Amador et al. (1975).

Although the data in Tables 8, 9, and 10 are not the best that could be hoped for to provide guides for determining the effectiveness of a program of protei fortification of wheat foods they are the best available. These data indicate that there is a wide variability in the consumption of wheat foods in Costa Rica and that the dispersed, rural, low socio-economic groups consume much less of these foods than do the higher income urban people. Commercial sales of protein

fortified wheat foods, therefore, would be more likely to reach the segment of the population least in need than the segment most in need of additional protein in their diets.

Of course, a purposeful program to increase protein intake by certain target groups could be undertaken by the government and would not have to rely on commercial sales. This could be achieved by subsidizing purchases of a protein fortified wheat food by the target groups distributed either through regular commercial channels or through govermment food distribution programs.

A program for distributing free food to children 12 years old and younger is in operation in Costa Rica. Protein fortified wheat foods could be added to the list of foods distributed under this program if the government decided to do so. This program (Asignaciones Familiares) and the factors that would probably be evaluated by the government in deciding whether or not to add a protein fortified wheat food to the program are discussed in other sections of this report.

Distribution and Retailing System for Wheat Foods

As indicated above, the major wheat foods consumed in Costa Rica are commercially produced breads, followed by other bakery products. On the basis of the quantity of different types of flour produced, the consumption of pasta products and crackers (galletas) is considerably below that for bakery products. Home baking is very minor with only 3 percent of the flour being used for this purpose. There is a network of small retail bakeries located throughout the country as well as a few large ones in San Jose. Pastas are manufactured in several factories, most of which are located in or close to San Jose. The status of the baking and pasta industries and the type, relative importance, and prices for the products produced are discussed in other sections of this report.

Nearly all bakeries sell some of their products at retail at the bakery and also sell to supermarkets and small retail outlets (pulperias) which are widely scattered throughout the country, except in the very remote rural areas.

In addition to these private sector firms, a government agency, the Consejo Nacional de Produccion (CNP), operates a network of 167 retail outlets located throughout the country. These stores sell not only foods on which the government fixes prices but also other foods - including wheat foods - in competition with the private sector retailers, thus, in effect, setting a price ceiling on most basic foods.

The CNP is also the sole supplier of foods purchased by the Asignaciones Familiares, a government program that is attempting to provide a major part of the nutrition to all children 12 and under. This program already provides 2 meals per day to an estimated 150,000 children and is targeted to reach 500,000 - 600,000 children by 1980. The criteria for selection of foods for this program are the following: 1) Nutritional balance; 2) use of domestic crops; 3) low cost; 4) consumer acceptance; 5) good storage stability; 6) ease of transport; 7) creation of new industries and employment opportunities; and 8) availability of the foods in the commercial sector. The only wheat food currently used in the program is a small amount of pasta. Although this product does not meet the criteria of "use of domestic crops," and, on a comparable nutrient basis, is higher in price than either corn or rice, it satisfies the other selection criteria. Two additional criteria that would militate against the selection of bread for this program would be poor storage stability and difficulty of transport, though baking on or near the use site would partly overcome these problems.

A stated objective of the child feeding program is to provide 80 percent of the caloric requirements and 60 percent of the protein requirements in the 2 meals. This objective would seem to place a constraint on the selection of protein fortified wheat foods for the program, especially if such foods were higher in cost than other selected foods that provided the same nutrients.

Another means of food distribution within the country is through CARE. CARE distributes supplementary foods that are donated under Title II of Public Law 480. Wheat flour provided to CARE under this arrangement is distributed through various government feeding programs for preschool and primary-aged school children and to pregnant and nursing mothers, primarily in rural areas. Recently CARE has been receiving wheat flour fortified with 12 percent soy flour which it will distribute through the feeding programs. An important part of CARE's programming effort in Costa Rica is to assist the government with its goal of substituting indigenous local foods to replace P.L. 480 commodities so that the feeding programs will be able to operate effectively as CARE and P.L. 480 participation are phased out.

A final means of wheat food distribution that should be mentioned - although it is quite minor - is a Seventh Day Adventist store located in San Jose. Although this store is insignificant in its total impact on food distribution, it manufactures and sells a number of foods that are blends of wheat and soy. Because of experience in producing and marketing these kinds of foods in Costa Rica, the persons associated with this store may be able to provide useful technical and marketing information to a larger program of protein fortification of wheat foods should such a program be introduced in Costa Rica.

WHEAT FOOD INDUSTRIES

Status of the Milling Industry

Costa Rica has one flour mill, Molinas de Costa Rica S.A., located in Alejuela, about 20 miles from San Jose. It is a modern, pneumatic plant built in 1967 with Mexican capital and Mexican-built equipment. The main mill grinds both hard and soft wheats. A smaller unit grinds durum to yield semolina. The total capacity is 7500 cwt flour per day, operating continuously 6 days a week. They can store 3-4 months wheat supply.

Wheat is purchased every 5-6 months from the United States for West Coast shipment along with that purchased by El Salvador. It is imported every 6 weeks at the Pacific Port of Puntarenas. The current purchases include about 75% dark hard spring, 10% hard red winter, 10% western white and 5% durum wheat. In the past small quantitites of soft wheat were imported from Mexico and Australia.

The modern wheat cleaning equipment includes a water wash using 500,000 liters/day. Flour extraction rate is 66-67% for bread flour and 70-72% for soft wheat flour on the same mill. (This may reflect different milling characteristics if no mill adjustment is made when different wheats are milled.). The product distribution is

- 78% bread flour
- 12% pasta flour (blend of 60% hard wheat and 40% amber durum)
- 3% household packs (2 and 5 lbs.)
- 3% semolina
- 4% pastry flour

The bread flour line includes a strong 13% protein flour and a product similar to topping flour in the United States. Small bakeries may use only bread flour for their entire range of products. Thus the high production of bread flour does not reflect only bread usage.

Except for household packs, flour is packed in 100 lb. cotton sacks, and aged 20 days in a large, clean, modern air-conditioned warehouse. Large orders (200 cwt) are delivered direct to customers at the government-set price. Smaller orders are picked up by the customer or made available through distributors who charge 4 colones (48¢ U.S.) for each sack delivered. Flour can be delivered to the most remote areas in 24 hours.

All flour and semolina are enriched with thiamin, riboflavin, niacin and iron plus calcium carbonate. Flours are not bleached but 75 ppm of potassium bromate are added at the mill along with diastatic malt where appropriate.

The well-equipped quality control laboratory determines wheat milling characteristics with Brabender equipment (dockage, moisture, Quadrumat junior). The resulting flour is further characterized by a farinograph, amylograph, extensograph and Theby gluten tests. If in doubt, a baking test is performed.

Mill production bread flour is baked twice weekly using a straight dough procedure and a pullman-type pan. Dough weights of 400, 500, 600 g. are tested in the same size pans to reflect the conditions used in the baking industry.

The selling price of flour and by-products is established by the government of Costa Rica, through the Ministry of Economics, Industry and Commerce. The most recent changes (decreases) were published September 7, 1976 in the official gazette (La Gaceta). They are summarized in Table 11. Current flour prices represent about a $1.00/cwt decrease from the previous price.

Molinas de Costa Rica appears to have the facilities and knowledge for developing a fortification capability. Because of the government's interest in yuca flour to include its use in extending wheat flour, mill personnel have assessed the technology needed for blending. While feasible, they estimate it would take more than a year to install the necessary equipment. The same time interval and technology would be anticipated if a protein flour were to be

Table 11

Wheat flours available in Costa Rica

TYPE	BRAND NAME	As of Sept. 7, 1976 MAXIMUM SELLING PRICE Major User 45.5 Kg	Retailer (Distributor) 45.5 Kg	Consumer Kg
High Patent Bread	Flores, Mas Pan	¢128.00	¢132.00	¢3.35
Topping Flour	Mercurio, Tres Munecas	123.50	127.50	3.25
Cracker or Pastry	Palatina, Palatina Esp.	128.00	132.00	3.35
Durum	Ambarina	138.90	142.90	--
	Semocrisa	168.90	172.90	--
Blend (60% DHW/40% Amber Durum)				
	Corona	124.00	128.00	--
All Purpose	Nacarina	(20 bags)	(20 bags)	(each bag)
20 bags @ 2.3 Kg per bag		145.50	149.50	8.60
50 bags @ 920 g per bag		155.50	159.50	3.65

C.R. ¢8.54 = U.S. $1.00

Source: La Gaceta (Costa Rica); Sept. 7, 1976

introduced at the mill. If outside help were needed, such technology might be made available through a consultant arrangement with U.S. millers experienced in supplying soy fortified flours for U.S. Food for Peace programs.

Support technology for determining quality characteristics of the protein materials could be obtained from CITA. This industry-supported organization has an active program developing food blends for government programs. They are in a favorable position to guide development of a functional protein concentrate for flour fortification.

Status of the Baking Industry

General -- Costa Rica has two distinct baking capabilities: one composed of 6 mechanized baking companies, processing 15 to 50 sacks of flour each day; and the other composed of many small, essentially hand-operated bakeries processing less than 15 sacks of flour. Estimations of their number range from 300 to 1500. A business census, currently underway, should determine the number.

Besides the differing levels of mechanization, the product mix also characterizes the bakery situation. The major products of the modern mechanized bakeries are sliced white bread, pullman style, and hearth-type French or Spanish breads. The small hand-operated bakeries produce the bulk of the price-controlled rolls (bollitos) available fresh daily. Some large bakeries also produce or distribute a limited number of bollitos at specified times in their stores.

The growth rate of bakery products was estimated by the major yeast supplier in Costa Rica at 5% per year. This indicates increased consumption since it is faster than the population growth rate of about 3%. At the same time, the small bakeries may represent a declining industry. One person estimated they might disappear in 15 to 20 years.

Large Mechanized Bakeries -- The six bakeries in this catagory are all located in the San Jose area; some have branch bakeries or outlet stores at other locations. Various operating and distribution systems are used. For example: 1. one company (La Selecta) has several in-store bakeries using the oven as a focal point for customers to observe oven preparation of the proofed, hearth type French bread. They see the baker transferring loaves to a semi-automatic conveyor belt, slashing the tops, and moving the loaves into a glass-fronted oven. They also have outlet stores in other cities; 2. Several companies have single bakeries with various distribution patterns. One (Pan Schmidt) distributes by truck to its own stores throughout San Jose and in Guanacaste and to several stores throughout the country.

They fly bread to the southern area near Panama. Others (Pan Roca and Pan Musmanni) have on-site sales areas and distribute to several supermarkets in the Central Meseta area. Distribution is often limited to 24 hour sales volume to prevent stale returns.

Large bakeries are equipped with 20-80 quart Hobart mixers. Some nave 200-300 lb.. capacity horizonal mixers. They have mechanical dividers, rounders and sheeters, but some substitute manual operations for dividing and rounding. Fermentation takes place in bowls or troughs and proofing generally on open racks wheeled to appropriate warm areas. No overhead proofers were seen, but may exist.

Both straight and sponge doughs are made. Some bakers set a few sponges overnight in cold rooms for early morning start up. Room temperature sponges are set for 4 to 5 hours. Sponge and straight doughs are molded after a short rest from the mixer. Scaling weights are 16 to 20 ounces.

The major product common to the large bakeries is sliced white bread, pullman style, packaged in plastic bags, sold in bakeries, supermarkets, pulperias (small family owned stores). Slicing is automatic, bagging requires 1 to 2 people, who use an automatic plastic-tie machine. Labeling requires the statement of ingredients and loaf weight. No standards are imposed. A typical label states enriched flour, water, yeast, sugar, salt, lard and calcium propionate, 0.25% as preservative. Weight for the same size bread selling in supermarkets for ¢4.00 (48¢ U.S.) ranged from 400 to 500 g.

Small Bakeries -- Small bakeries are located throughout the country in communities large enough to support them. In the San Jose area they are located in residential neighborhoods as part of a small grocery store (pulperia) or as a separate establishment. There may be one bakery every 4 blocks in some communities with on-site sales and truck delivery to grocery stores in the community. The

major product, the small government-price controlled roll (bollito) is made fresh each morning and sold from a basket without wrapping.

One to 3 employees may process 1 to 15 sacks of flour per day in one large room equipped with tables, a dough trough, a sheeter and sometimes a slow dough mixer. A typical oven is brick, about 10 to 12 ft. square, with a domed internal cavity about 3 ft. high at the center. Heating is by a portable kerosene-fired gun placed at the opening prior to baking. A one-hour firing is adequate for 4 to 5 hours baking. Wood is too expensive for heating ovens.

The major product of the small bakeries is the government price-controlled roll (bollito) containing flour, fat, salt, sugar and yeast. These are prepared by a straight or sponge dough procedure. Dough mixing is usually by hand with fermentation in a wooden trough. In the absence of a mixer, the mechanical dough development occurs during sheeting of fermented dough pieces through a pie dough sheeter several times with folding crosswise or longitudinally at each pass. This is followed by manual scaling and shaping for final proof.

At one location, a mechanical mixer was equipped with a rotating bowl and stationary heavy blade, angled to provide some mixing of dough ingredients. Dough development occurred in another rotating bowl equipped with a stationary vertical sheeter. The dough was continually sheeted during bowl rotation.

Five hour sponges were common. After dough mixing, zero time to 2 hours elapsed before final makeup. If straight doughs were utilized, fermentation ranged from a short rest to 3 hours before makeup. Final dough pieces of approximately 30 g. were elongated and shaped by hand, placed close together in groups of 5 on shallow-trays. After proofing at ambient temperature, they were baked for times dependent on the uncontrolled oven temperature. The baked pieces are sold individually or commonly in units of 5 or 10. By law, the baked pieces should weigh at least 25.5 g., selling for 15 centimos (1.8¢ U.S.).

Other common products from the same fermented doughs were bread sticks and a donut-shaped piece formed from the bread stick.

The major unfermented product was a lean slightly sweet cookie or cracker-like piece (galleta) cut from rolled out stiff doughs, docked, and baked at low heat. Little or no browning occurred. They usually contained flour, sugar, fat, salt and baking powder. At times a yeasted dough was used. At one location these weighed about 5 grams each and sold 6 for 25 centimos (3¢ U.S.). Their popularity and storage stability suggest them as a potential vehicle for fortification.

Other products included soft cookie-like pieces or bars prepared from 50 to 75% sugar doughs, mixed, rolled, and flattened by hand, some containing a guava jelly filling.

Often the same bread flour is used for the complete range of products in a small bakery. Up to a week's supply is stored in the bakery.

Fortification Potential of Specific Bakery Products -- For the purpose of selective fortification of a bakery item, three products would give the most promise for reaching the largest number of people and being consumed in significant amounts for nutritional impact. These are sliced, white, pan bread; small rolls (bollitos), and sweet crackers (galletas).

The pan bread is produced by mechanized bakeries with a level of sophistication adequate to adapt new fortification or composite flour technology. Evidence of past success was noted in the range of hearth and bread products already available; e.g. whole wheat, sour rye and a new high fiber bread introduced in October, 1976. (This product contains high levels of bran, germ and sesame seed.) The major modification anticipated for high-protein bread would be the use of straight doughs rather than sponge unless the protein concentrate was added at the dough stage. Scaling weights at the high end of the present range (20 oz) would be needed to prevent overproofing in order to fill the covered pullman pan. Present shortening

levels (3%) with or without dough conditioners should insure adequate loaf volume.

The bollitos would appear to be the product most likely to reach the target group expected to need the added nutrients because they are price-controlled and produced in residential neighborhoods. They could be protein-fortified using known technology and straight dough procedures. Because strong bread flours are used in Costa Rica, the dough development by sheeting rolls should be sufficient to maximize effectiveness of fat and dough conditioners. Similar methods are used successfully with soy-fortified flours in other countries, e.g. Philippines.

Galletas, low moisture cookies have the advantage of a storage stable product that can be shipped to rural areas and stored without deterioration. Its slight sweetness makes it particularly acceptable for children. U.S. studies on other types of protein-fortified cookie products would suggest that galletas could be protein-fortified without adverse quality changes. Experiments would have to be performed to assess process modifications needed.

To aid in the evaluation of the most appropriate product for protein fortification, the information in Table 12 was developed. It gives an analysis of several Costa Rican wheat-based products, emphasizing protein level and cost and compares protein and calories in 100 g of edible product (prepared for serving).

If total cost is charged to protein, the bollito represents the least expensive product, pan bread the most expensive. Spaghetti protein cost is relatively low, unless preparation costs become significant.

Nutrients in 100 g of edible product vary mainly with the water content. In addition, the protein in galletas is diluted by the high fat content (ave 8.9%) which supplies significant calories.

Table 12
Costa Rican Wheat Products
An Analysis of Oct. 1976 items

As purchased	Bollito	Bread	Galleta	Spaghetti Raw	Spaghetti Cooked Al dente serving	Spaghetti Cooked Tender serving
Unit	1 roll	1 loaf	6 crackers @ 5 g. each	1 pkg.		
" Weight, g.	25.5	400-500	30	200 g.	100 g.	100 g.
" Cost, ¢ (colones)	0.15	4.00	0.25	1.70		
Moisture, %	35 1/	33 1/	7.1 2/	16 3/	64 4/	73 4/
Total solids per unit, g.	16.6	248-310	27.9	168	36	27
Cost per g. solids, ¢	.0090	.0129	.0090	.0101	raw + preparation cost	
Flour, % of solids	91.7 5/	87.75 5/	No formula information	100 5/	100	100
Protein, % of solids	12.8 6/	12.24 6/	9.53 2/	13.95 6/	13.95 6/	13.95 6/
Protein content of unit, g.	2.12	37.94	2.69	23.44	5.02	3.77
Cost of protein 7/, ¢/g.	.0708	.1054	.0929	.0725	.0725 8/	.0725 8/
100 g. edible portion						
Protein, g.	8.31	7.59	8.97		5.02	3.77
Calories, C	277	252	408		144	108
Cost, ¢	0.59	0.80	0.83		0.36 8/	0.27 8/
Solids content, g.	65	62	92.9		36	27

1/ Estimated
2/ Analyzed at WRRC
3/ Food composition tables for use in Latin America (INCAP-ICNND)
4/ USDA Handbook #456
5/ Based on known formulas
6/ Based on flour at 12% protein and 14% moisture
7/ Cost of product charged to protein
8/ + Preparation cost

Status and availability of minor baking ingredients

Vitamins (thiamin, riboflavin, niacin) and minerals (iron and calcium) are added at the flour mill using U.S. levels of enrichment.

The oxidizing agent, potassium bromate is added at the mill at 75 ppm to bread flours. Some bakers add Arkady yeast food which also contains $KBrO_3$. It is purchased from Pan American Standard Brands, Inc.

The mold inhibitor, calcium propionate, also purchased from Pan American Standard Brands is added to bread formulas by the large bakeries at 0.25% level. It is ¢8.75/lb. ($1.025 U.S.).

Hydrogenated fat is a palm-oil based product manufactured in San Jose by United Brands. Use levels in baked products ranged from 3% up. Margarine and cooking oils are made from cottonseed imported from El Salvador by United Brands.

Dough conditioners are imported from the United States. Emplex (SSL) is the only dough strengthening compound available at a cost of ¢22.00/lb. ($2.64 U.S.) from C. J. Patterson Co. Emulsifier and softener type compounds are available from Atlas Chemical Company through United Brands. They include Atmol, Altex and Mono-Short.

Sugar is government controlled. Three types are available: refined table, regular (bakers), and super-crystal containing molasses. The regular bakers sugar costs U.S. 11¢/lb.

Compressed and active dry yeast is manufactured in San Jose by Pan American Standard Brands. Compressed, delivered in the San Jose area is ¢ 2.75/lb. (32¢ U.S.). Active dry yeast is available in 2, 10, and 25 lb. sizes for ¢7.20 to 7.56/lb. (84-88.5¢ U.S.).

Status of the pasta industry

One large and several small companies characterize the pasta industry. They produce for Costa Rica and for export to other Central American countries. The large company (Roma-Prinz) is a subsidiary of the U.S. company located in Lowell, Massachusetts. They have a modern, new plant in Alajuela nearing completion which will increase their processing capacity to 8000 cwt flour per month from the present 1500 cwt. They make a wide range of American-type pastas from durum semolina which costs ¢168/cwt. Similar products are made by the smaller companies, some with semolina, but greater amounts with the blended flour, containing 60% dark hard winter and 40% amber durum and selling for ¢124/cwt. The government sets a lower price on the blend in order to provide a reasonably-priced pasta for popular consumption. Table 12 provides information on protein content and cost of spaghetti in Costa Rica compared with bread and galletas.

The government's Asignaciones Familiares program uses macaroni made from the 60-40 blend and presently supplied by the smaller pasta manufacturers. If they expand the program and include protein-fortified pastas, they would probably have to look to Roma-Prinz for technology and quantities needed. Roma Prinz's U.S. parent had produced protein fortified pastas for the U.S. school lunch program and is studying such products for possible submission to Asignaciones Familiares for their consideration.

A composite flour pasta was observed in production at Industrias Las Palmas, S.A. at Palmares. Seventeen percent dry corn masa was blended with 83% hard wheat flour, made into a dough with the same moisture content as all wheat pasta, and extruded on a Braibandi extruder and dried. This corn masa was prepared by steaming whole white corn 5 minutes in a vertical cylinder, dropping it on a shaking screen with air for cooling and drying, and then grinding to a flour in two sequential stone mills. A somewhat better (but more expensive) composite flour pasta had

been previously made wherein the corn was first partially dehulled. The color of the composite flour pasta was a light tan compared to the amber of durum pastas. Both the odor (dry) and flavor (cooked) differed significantly from all wheat pastas. However, the manufacturer claimed this low cost, composite flour pasta represented 50% of his market. It has a significantly lower cost, ¢2.0 per lb. compared with ¢3.4 for traditional pastas. This is achieved by the lower cost of corn and use of bulk marketing procedures instead of the household packs used with the all-wheat pastas.

Jose Gonzalez, CITA noted that rice and corn must be cooked for use in pastas. This can be done by drum drying, steaming as described above or by extrusion cooking. The steaming process was said to be used in Colombia.

PROTEIN SOURCES

Currently, there are no locally available sources of protein in Costa Rica that can be used for protein fortification of wheat foods. Two potential sources exist, however, which are evaluated below. These are soybeans and concentrated wheat protein made from wheat milling fractions.

Soybeans

Production -- Although there is no commercial production of soybeans in Costa Rica at present, a number of different investigations have been carried out by various groups in the past 10 to 12 years to evaluate the possibilities for soybean production. Many varieties have been tested in several locations with most varieties being eliminated because of disease problems and low yields.

A few varieties have shown promising results under experimental conditions and further testing under commercial conditions is underway with support from the government, CARE, USAID, the University of Costa Rica, and others.

With regard to yields, the best varieties under experimental conditions resulted in yields of anywhere from 2.0 to 3.1 MT per hectare. It has been estimated that under commercial conditions the average yields of these varieties could be from 1.5 to 1.8 MT per hectare. Thus, it would seem that soybean production in Costa Rica is technically feasible.

Whether or not production of soybeans is economically feasible will depend upon production costs under Costa Rican conditions and the world price for soybeans. Five production cost estimates on 1974-75 experimental scale operations have been made. These estimates ranged from 2,852.40 to 8,750.35 colones per hectare. One analyst averaged these cost estimates, apparently weighting each by the yield and the area under production and arrived at an average cost of 3,635 colones per hectare or 1,928 colones per MT.

During the period under study -- a period of unusually high prices for soybeans -- the price of imported soybeans from Nicaragua reached 3,080 colones per MT. Under these conditions, it would seem that soybeans would be an economically feasible crop for Costa Rica. In view, however, of the small size of the experimental plots, the wide range in the cost estimates, and the unusually high prices for soybeans when the feasibility estimates were made, these data should be used with extreme caution. In addition, to develop large-scale commercially feasible production of soybeans in Costa Rica, many problems, particularly those associated with transferring technology to a large number of small farmers, would have to be overcome. Such problems cannot be expected to be solved in a short time and without considerable effort and cost.

Markets for Soybean Products -- At present there is very little use of soybean products in Costa Rica. The quantities that are used are mainly for industrial purposes (oil) and animal feeding (meal). The small amounts of soy products that are imported are in a processed form rather than in the form of whole beans as there are no commercial processing facilities in the country for extracting oil or otherwise converting soybeans into products. The only exception to the lack of any whole soybean imports are the small quantities used for seed for experimental plantings and for the products processed by the Seventh Day Adventist store.

In 1974, a total of 734 MT of soybean oil was imported by Costa Rica which was less than 10 percent of all vegetable oils imported that year. Most of this oil was used for manufacture of paint and related products. In the same year, about 28,000 MT of oilseed based meal was imported, the major part of which was cottonseed meal from Nicaragua. According to one source, less than 4,000 MT of soybean meal is imported annually and is used entirely for animal feed. Another

source indicated that while there is no import duty on soybean products for feed, there is on food grade soy.

Very small quantities of soy are used for food. This includes trivial quantities of toasted soybeans sold in some supermarkets as a snack food that competes with salted nuts, etc.; some soy containing wheat based foods sold by the Seventh Day Adventist store; the soy containing wheat flour and other products distributed by CARE; and, recently, a mixture of corn flour and 8 percent soy flour which comes from Mexico and is used for making soy fortified tortillas (Tortillas Tortiricas) that are distributed widely throughout Costa Rica.

Experimental work is going on by CARE, by CITA and by some private firms to develop acceptable food uses for soybeans. A black-hulled, Brazilian variety of soybean - one of the varieties that has shown favorable yields under experimental conditions - is undergoing extensive experimental work by CARE both from the standpoint of production and utilization. This variety is similar in appearance to the traditional black bean eaten by much of the population and is nutritionally superior. On an experimental basis, black beans have been successfully extended by 20% with black soybeans. One aesthetic problem identified was that the soak-water becomes dark brown. With regard to production of soy flour for incorporation into wheat foods - which is discussed below - the black hull cannot be completely removed and, therefore, leaves black spots in the flour. Dr. Steinberg, University of Illinois, is working on dehulling. Currently, about 92% of the soybeans are dehulled; they hope to increase this to 97%. Pelican is a white soybean variety that has shown agronomic promise -- its use in production of soy flour avoids the dehulling problem.

Since Costa Rica imports substantial quantitites of vegetable oils (7,384 MT in 1973) and since most of this is cottonseed oil which is used for industrial uses,

soybean oil produced from locally produced soybeans could replace this oil and the soybean meal produced from such an operation could replace the imported cottonseed meal from Nicaragua. The key question, of course, is can enough market outlets be developed to build processing facilities that are large enough in capacity to produce these products at competitive prices. This question is outside of the scope of the potential feasibility of fortifying wheat foods with protein so no attempt will be made to answer it here.

An evaluation of the possible uses of locally grown soybeans for production of whole soy flour is within the scope of this study and is a question we turn to now. Experimental work for producing full fat soy flour and incorporating it into various foods is already underway in Costa Rica. This work is being done by CITA, by CARE and by several private groups. This is in addition to the commercial products being made by the Seventh Day Adventist store.

An experimental product containing banana, rice, and whole soy flours for possible use as a breakfast cereal (infant food) has been developed by United Brands and is being tested for possible use in the Asignaciones Familiares feeding program.

With regard to using full fat soy flour in wheat foods, if, as a maximum, it is assumed that 10 percent of all wheat flour was to be replaced by locally produced soybeans, this would require 5,360 MT of dehulled, full fat soybean flour per year (53,600 MT of wheat flour X .10). To produce 5,360 MT of full fat-soybean flour would require 6,700 MT of soy beans and a minimum of 3,400 hectares of land. If this area was grown in plots of 2 hectares, this could result in employment for 1,700 small farm operators and many adjunct employment opportunities. It also would result in a foreign exchange savings of $1.52 million per year because of a reduction in wheat imports of 8,000 MT at $190 per ton. Such a replacement would have to take place gradually to allow production to grow sufficiently to meet demand, but if it is to take place at all a key question is its economic feasibility.

Another important question is whether or not consumers would accept wheat foods containing soy flour and at what prices.

No information is available to attempt an answer to the latter question at this time. With regard to economic feasibility, several factors would have to be considered. These include the price of the raw material (soybeans), the yield of soy flour and equipment, building, and operating costs. If soy flour was to be considered for use in government supported feeding programs, another consideration would be the cost to the government for foods that would provide the same nutritional use.

One estimate of the cost of producing soy flour in Costa Rica made by AID shows a cost of 1.96 colones per pound. The assumptions for this analysis and the cost estimates are shown in Table 13.

Table 13

Cost estimates for producing soy flour in Costa Rica, 1975

Item	Input	Cost per hour
		Dollars
Soybeans	380 Kg/hr x $0.23/Kg.	87.40
Labor	4 men x $0.50	2.00
Equipment	$2,000/year	1.00
Building	$2,000/year	1.00
Packaging1/	300 Kg/hr @ $0.10/Kg.	30.00
Overhead	25% of all other costs	30.35
Total		151.75 2/

1/ Yield of flour from 380 pounds of soybeans is 300 pounds due to dehulling and moisture losses.

2/ Cost of soy flour $\frac{\$151.75}{300 \text{ Kg.}}$ = $0.51/Kg. - 1.96 colones/lb.

Source: The market for soybeans in Costa Rica, AID/RDO Costa Rica, 12/18/76, unpublished.

The capacity of operation used for this cost estimate was based on the capacity of a Brady Crop Cooker which can be used for extrusion cooking of whole soybeans which can then be ground into a flour. There is a Brady Crop Cooker in Costa Rica which is currently being used experimentally.

It is not clear how building and equipment costs were arrived at, nor what is included in overhead; therefore, it is difficult to evaluate the validity of the above cost estimate. On the basis of conversations with several persons in Costa Rica, however,it would seem that this cost estimate is too low. One possible understatement of costs could be in the price used for soybeans. As indicated earlier, the price of imported soybeans was estimated to be $0.36 per kilogram delivered in Costa Rica around the time the cost estimate was made. The price of $0.23/Kg. for soybeans used in the cost estimate for soy flour is the average estimated cost of production discussed above. The IMAS/CARE experimental soybean project pays the farmers $0.36/Kg. This price would return farmers an income that is roughly equivalent to what they would receive if they grew traditional black beans and is, therefore, a more realistic price. Had this price been used, the estimated cost for soy flour would have been $0.67 per Kg. or 2.57 colones per pound.

Another estimate of the costs of producing soy flour with a Brady Crop Cooker was made by a U.S. worker (Stone 1976) using price of inputs that might be "typical" in a developing country. This analysis resulted in a cost of 0.92 colones per pound. There were wide differences in the prices for different inputs between this analysis and the one made by AID in Costa Rica. One major difference was in the price of soybeans which was estimated to be about $0.13 per Kg. compared with the $0.23 per Kg. price used in the AID analysis. If a price of $0.36 per Kg. were used for the price of soybeans in both studies, the cost of the flour would be about 1.88 colones per pound for the U.S. estimate as compared to the 2.57 colones per pound estimated for the AID study. Furthermore, although labor and

packaging material costs were about the same for the two studies, the capital costs and overhead per unit of output for the AID study were based on a plant of much smaller capacity and were, therefore, higher per unit of output.

If the GOCR were considering the use of soy flour in its feeding programs, one question that would likely be raised is the cost compared with an alternate food that would provide equivalent nutrition. Although there are differences in the nutrient composition of soy flour and dry beans, and the costs of utilizing the two products may be different, a comparison of the costs of the two products might be as good a basis as any for nutrition planners to decide whether or not to give further consideration to use of soy flour in government feeding programs. Using the highest of the above estimates for soy flour and the October 1976 fixed wholesale price for dry beans, we find the prices roughly comparable: 2.57 colones per pound for soy flour and 2.28 for dry beans. Thus, assuming this cost estimate is valid, a decision to use or not use soy flour in the government feeding programs would have to be based on other criteria: 1) Does the government wish to encourage production of a new crop that could be used to substitute for many agricultural products that are now imported; 2) would a greater variety of foods in government feeding programs be desirable; 3) would those in the programs accept foods containing soy flour?

Even if the foregoing questions were answered affirmatively, the questions of how soy flour should be used and whether it should be used for fortifying wheat foods would still be left unanswered. Since the GOCR is emphasizing the use of locally produced foods, it seems unlikely that wheat foods will be used in more than token amounts in government financed feeding programs. Therefore, if soy flour is considered for use in these programs, it is more likely to be evaluated for use in foods that are based on rice or corn such as, for example, in the banana, rice, soy infant food mentioned earlier.

There may be a demand in the commercial market for some wheat foods fortified with soy without any significant importance given by consumers to the somewhat higher price or to the possible nutritional advantage. It would seem, however, that such a demand would be similar to that for other specialty breads, and therefore, limited. To achieve a larger scale use of protein fortified bread, the government probably would have to legislate and subsidize its use. If the objective were to replace an imported commodity with a domestically produced one, it would be more logical to do so with a commodity which is already locally grown and lower in cost than wheat flour. Commodities that might be considered include yuca, rice, and corn which are evaluated below in the section on carbohydrate sources for composite flour.

Concentrated Protein from Wheat

One of the seemingly most simple ways for Costa Rica to reduce its dependence on imported wheat and at the same time reduce the costs of wheat foods and improve their nutritional value would be to extract more of the wheat grain for use as food than is presently being done. This could be done by increasing the extraction rate of edible flour from wheat - which in Costa Rica runs around 67 percent - and reducing the quantity of residual millfeeds which are fed to livestock. The extraction rate of bread flour from wheat runs about 80 percent in Guatemala and 76 percent in the United States. Since the price of bread flour in Costa Rica in October 1976 was about 128 colones for 100 pounds and the average price of millfeed was about 21 colones, the price of flour could be reduced by increasing the extraction rate and at the same time could save on foreign exchange and, perhaps, improve the nutritive value of wheat flour. Consumer acceptance of a higher extraction flour in Costa Rica is not known although, reportedly, white flour and white bread are "status" foods and preferred by the majority of the population.

An alternative approach to achieving a greater utilization of imported wheat for food is to extract the most nutritive part of the millfeed by a dry mechanical process resulting in a product that has been named "Concentrated Wheat Protein" (CWP) (previously known as wheat protein concentrate or WPC). In this process, the millfeed is subjected to more severe grinding and more thorough separation than in the normal milling process to obtain a flour which ordinarily is considered too dark in color and too high in ash to meet the standards for white flour. About 10 percent of the millfeed could be easily recovered as CWP with a protein content of around 20 percent, up to 25% yield may be possible. This product could be used for protein fortification of breads and pastas as well as in other uses in any proportion desired and, therefore, allows a greater flexibility than increasing the extraction rate of bread flour from wheat.

The process for making CWP is relatively simple and can be carried out with a number of different types of equipment. The costs would depend upon the type of equipment used, its delivered prices to the installation site, the costs of installation, and labor and utility costs. The price of the CWP would depend on the demand for it as well as the reduced nutritional value of the millfeed from which it is made. One U.S. estimate (Daftary et al., 1976 unpublished) for the costs of processing millfeed and treating it for enzyme deactivation and improved storage stability, assuming a 10 percent extraction, is $0.358 (3.0 colones) per 100 pounds of CWP extracted. This does not include the cost of the starting material (millfeed) nor the cost of packaging.

In Costa Rica, three types or grades of millfeed are produced ranging in price from 13.8 colones per 100 pounds to 24.0 colones for the highest protein millfeed and averaging 21.0 colones. Assuming that CWP is extracted from the millfeed with the highest protein content at a 10 percent rate of extraction and the value of

the millfeed so processed is reduced to the average value of all millfeed, the estimated costs for producing and packaging 100 pounds of CWP would be as follows:

	Cost/100 lbs. of CWP
	Colones
Cost of starting material	24.0
Discounted value of 900 lbs. of the highest protein millfeed	27.0
Processing costs	3.0
Packaging costs, hundred pound cotton sacks	8.5
Total	62.5

It must be emphasized that these costs are based on assumptions that may not be valid. More valid cost estimates would have to be based on a comprehensive analysis using Costa Rican conditions. In any case, the price of CWP would be based on the price of millfeed,which is lower in price than wheat (24.0 colones per 100 pounds compared to 70 colones), and, therefore, in no case would be expected to be as high as the price of flour. Even if it were as high as flour, its use in wheat foods in Costa Rica would still have the advantage of reducing dependence on imported wheat and of improving the nutritive value of wheat foods.

CARBOHYDRATE SOURCES FOR COMPOSITE FLOUR

As indicated above, nutrition studies have concluded that the shortage of food energy is a greater problem in Costa Rica than the availability of protein. In view of this and the government's objective of encouraging production and consumption of local crops, consideration should be given to the use of low cost indigenous carbohydrate sources for extending wheat flour, all of which is made from imported wheat. Three crops which can be used for this purpose, each of which has some possible advantages over the others are yuca, rice, and corn.

Some of the criteria that will need to be considered in evaluating these crops for this purpose are consumer acceptance of the final product, present and potential production and supply of the crop, and the prices of the form of the crop that would be used in wheat foods. Some of these factors are discussed below.

Yuca

Production of yuca is widely distributed throughout Costa Rica but is heavily concentrated in the areas of low altitude and high humidity. Over half of the total production is in the province of Alajuela, with another quarter in the province of Limon.

According to government records, total production of yuca in Costa Rica increased steadily from 98,866 quintales (1 quintal = 1 cwt.) in 1955 to 299,711 quintales in 1973. Estimated production in 1974 was 324,287 quintales. Substantial quantities are eaten on the farms on which they are produced (about 10 percent of the total production in 1973) and in recent years exports have increased substantially, rising from a deficit in 1967 to about 7 percent of total production in 1974.

Between 1955 and 1973, the number of farms producing yuca grew from 2,457 to 3,209. During the same period, the harvested area of yuca increased from 1,571 hectares to 2,077 hectares, and production increased dramatically from 59.47 to 144.30 quintales per harvested hectare.

In 1973, of the 3,209 farms producing yuca 2,642 - 82 percent of the total - produced less than 1 hectare. Another 328 farms - about 10 percent of the total - produced from 1 to 2 hectares. These 2 groups of farms - 92 percent of the total produced slightly over 50 percent of the total crop.

Compared to some other countries in Latin America, the consumption of yuca in Costa Rica is low but has been increasing. In the 10 year period from 1963 to 1973, annual per capita consumption grew from 4.46 to 6.67 kg. per person. This compares with 124 kg. per person in Brazil. Although no data could be found to show the consumption by region and income group, it seems reasonable to assume that more yuca is eaten per person in the regions where the production is heaviest. The reasons for this are because of the difficulty and high cost of transporting this bulky and perishable crop over long distances and because the areas of major production are in the lower income rural areas where yuca is readily available and is a low cost carbohydrate source.

Since yuca is already an export crop in Costa Rica and its production apparently can be increased further, a supply for processing into yuca flour would seem to be assured. If such flour was to be incorporated into wheat foods, most of it probably would be eaten by a different group of people than eat yuca as a vegetable. This new market for yuca would result in reduction of wheat imports and a more favorable balance of payments as well as creating new employment opportunities at the farm level and in processing plants located in rural areas near the source of raw product supply. There are currently two plants processing yuca, one at Peralta, the other at Florencia, both in Alajuela Province.

A "debate" is currently underway in Costa Rica as to whether or not the government should legislate the compulsory use of yuca flour in bread and other wheat foods.* Proposals have been made for incorporating up to 20 percent yuca

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* Several Latin American countries already have laws requiring the addition of yuca or some other flour produced from a local crop to wheat flour. A Costa Rican funded study of the experiences of other South American countries on this subject has been carried out (Arias, 1976).

flour into wheat flour in Costa Rica. The wheat foods industries have taken a position against such legislation, arguing that the addition would cause bakery production problems, decreased product quality, and increased costs. It was further argued that more time is needed for development and testing of suitable formulations and for installing required metering equipment at the flour mill for achieving uniform blending. In September 1976, a law requiring the blending of 3 percent yuca flour into bread flour was passed but apparently is not being enforced because of such reasons as "insufficient time to install necessary equipment at the flour mill". Furthermore, arguments have been presented to the government that in other countries where such laws have been passed, the industry has not carried out tne edict because of consumer resistance to the less desirable quality of products made from composite flours (Arias, 1976). Another counter argument is that if 3 percent yuca flour was added to the entire flour supply there would be a loss in consumption of 165,000 kg. of protein to the population.

In view of the government's desire to encourage the use of locally grown crops the "debate" is probably not over. With respect to the effect of yuca flour on the quality of wheat foods, more testing under controlled conditions and consumer acceptance tests with different levels of substitution should provide more definitive answers. CITA has proposed a study of composite flour technology including yuca and wheat flour mixtures. One test run by a USDA laboratory on a single yuca flour provided by a sales respresentative of one of the yuca flour manufacturers in Costa Rica showed the flour had very undesirably high total and coliform bacterial counts indicating contamination or unsanitary processing conditions. Baking tests at the USDA laboratory on the same yuca flour showed that technology exists for using it up to 5% with only marginal effects on organoleptic qualities of white bread.

Should the problem of quality be resolved then questions of economics would become primary. Aside from the government's desire to encourage local production,

reduce imports, have a more favorable balance of payments, and encourage local industry, all of which could be accomplished through legislating the use of a certain percentage of yuca flour with or without a subsidy, if the economics were favorable, private industry might add yuca flour to wheat flour even without such legislation. In fact, yuca flour is reportedly already being used to a limited extent in some foods in Costa Rica. Small quantities are used in some pastas, sausages, and some bakery products. One cookie formulation is made with a 50-50 mixture of yuca and wheat flour.

Costs of producing yuca flour are not available, but the price at which one of the 2 yuca flour producers reportedly can sell yuca flour and make a reasonable return is currently 125 colones per 100 pounds. With the price of bread flour at 128 colones, there would be no incentive to use yuca flour. According to a yuca processor representative, if the price could be dropped to 100 colones per 100 pounds he would have a sizeable market from bakers who would add it to bread at the rate of up to 4 percent of the flour requirement.

If yuca flour were substituted in all wheat flour used in Costa Rica at the rate of 3 percent this would require 1,608 MT of yuca flour (80,000 MT wheat x .67 extraction x .03) per year. The capacity of one of the plants producing yuca flour in Costa Rica is 20,000 pounds of flour, or about 9 MT, per day. Thus, it would take only 178 days of operation per year for this plant to produce the necessary amount of yuca flour. In order to be able to operate at capacity rates for the entire year and thus perhaps to lower costs sufficiently to provide an economic incentive to add yuca flour to wheat flour, the rate of addition would have to be increased to 6 percent or additional outlets, either domestic or export, would have to be found for yuca flour. Another possibility for enabling these plants to operate at capacity would be to expand markets for yuca starch and/or other yuca products for food, feed, and industrial uses.

Corn

The Government of Costa Rica is firmly committed to a policy of self-sufficiency in the production of basic grains (corn, rice, beans, and sorghum). Various programs and incentives, including high guaranteed purchase prices, are being used to stimulate production of these four crops. Traditionally, corn has been grown on small farmer subsistence plots with low levels of technology and low yields. The high guaranteed prices, however, have begun to attract larger-scale producers who find it economically attractive to plant corn on a large scale using modern technology.

Corn production is widely distributed throughout Costa Rica but about three-fourths of the land area planted to corn and three-fourths of the production are in three regions of Pacifico Seco, Pacifico Sur, and Meseta Central (see map in Appendix).

Total production of corn in Costa Rica has remained relatively stable from year to year for at least the past quarter century. According to government statistics, the total land area devoted to corn production actually declined from 55,023 hectares in 1950 to 51,889 hectares in 1973. Average yield per hectare was 1.09 MT in 1950 and 1.01 MT in 1973. Thus, total production of corn was 59,916 MT in 1950 and 52,446 MT in 1973.

Because government programs are attracting larger-scale production and because economic incentives encourage the use of modern technology, the area of production devoted to corn as well as yields are expected to increase rapidly. A study made by the CNP for planning the capacity and location of basic grain storages throughout Costa Rica projects the land area, average yields, and production of corn to 1985. This study indicates an area of 97,830 hectares with an average yield of 2.13 MT per hectare. This is an increase of about 85 percent in the land area over 1973 and a doubling of yields for a total estimated production of 207,920 MT - a quadrupling of 1973 production. Corn production for 1975-1976 is estimated by the CNP to be 91,745 MT which indicates that government programs are already having some success in achieving desired goals.

Since Costa Rica currently imports about half of its requirements for corn, and since the population is expected to increase by about 25 percent in that time, and since feeding of corn to livestock is increasing, much of this added production will be taken up by domestic requirements. Per capita consumption of corn is expected to remain stable at 60 pounds which in 1975 resulted in a total consumption of 53,441 MT. With the population increase, this will increase to an estimated 66,419 MT by 1985. Feed use of corn was 59,800 MT in 1975 and is expected to be 80,362 MT in 1985. Thus, total domestic consumption will increase from 113,241 MT in 1975 to an estimated 146,781 tons in 1985.

If the projections to 1985 are valid, that year Costa Rica will have in excess of 60,000 MT of corn over projected demand. With the growing global need for food, there will no doubt be a market for this excess. Nevertheless, if domestic demand for corn can be increased to replace part of the imported wheat, the country would benefit economically. Costwise, corn could compete quite effectively as a wheat extender. For the past 3 years, the government guaranteed price on corn has been 75 colones per 100 pounds with the wholesale price set at 78 colones. No cost estimates for milling corn are available for Costa Rica but some approximations can be made.

In earlier times, corn milling in the United States was accomplished primarily by grinding whole corn on stone mills. Such corn meal was highly nutritious and if used quickly was quite palatable. Any length of storage, however, resulted in development of free fatty acids and strong soapy and bitter flavors. Stability and palatability could and was improved by bolting or sieving the meal to remove part of the hull and germ. Such operations continue to be successfully used, e.g., in Kenya, where 80-90% yields of edible flour-meal is recovered. The cost of this type of operation is relatively low compared to the more complex milling processes practiced in the United States today where the corn is completely degermed and dehulled yielding corn endosperm products of blander flavor, improved stability and greater utility in product development. Nutritional losses in vitamins and minerals have been partly made up by

enrichment. The change to a dehulling and degerming process was enhanced by recovery of corn oil from the germ fraction and also by the ready feed markets for residual millfeeds of the operation. Dehulling and degerming operations for corn have been observed by the authors in Bolivia and Paraguay. The yield of corn endosperm is in the area of 60%. The value of the millfeed for feed is generally similar or slightly less than the whole corn because of its high protein and oil content (germ). If we use the gross margin apparent for milling wheat in Costa Rica, (23 colones per cwt of wheat) we have the basis for a crude estimate of the cost of corn flour.

The cost of 100 lbs of corn is 75 colones. Add to this 23 colones for the milling and profit costs for a total cost of 98 colones per cwt. Using a value of 60 colones per 100 lbs of corn millfeeds, the 40 lbs of millfeeds produced from 100 lbs of corn would have a blue of 24 colones. Subtracting the 24 colones from 98 colones gives 74 colones for the value of the 55 lbs of corn meal or flour (shrinkage is taken as 5% or 5 lbs). This is equivalent to 134 colones per 100 lbs of corn flour or slightly more than wheat flour at 128 colones per 100 lbs.

Corn dry milling processes and products are discussed by Brekke and Brockington in the 1970 Avi Publishing Company book: "Corn: Culture, Processing, Products". There are many different machines and processes for corn dehulling and degerming -- from roller mills, Entoletors and granulators to Beall degermers specifically designed for the job. The complexity and cost of corn dry milling can vary substantially depending on the products required (corn grits vs flour) and their quality specifications. In addition, Miag of Braunschweig, Germany and Ocrim Sp. A. of Cremona, Italy have introduced (1967-68) equipment for degerming and dehulling <u>untempered</u> corn eliminating the expensive tempering (moisturizing) and subsequent drying steps typically practiced in the United States. Finally, it can be said that the variety of corn is important in the yields of products from corn dry milling

operations. Where grits are to be produced, a high percentage of horny or vitreous endosperm is desired whereas when flour is to be produced, a soft corn averaging 20% horny and 80% floury endosperm would be desired.

Whether or not consumers would accept corn flour-wheat flour blends in different wheat foods and at what levels and prices can only be determined through consumer and market testing. One pasta manufacturer is currently making a pasta product consisting of 83 percent wheat flour and 17 percent corn flour which is sold at a lower price than pasta made only from wheat flour and for which there appears to be good acceptance. Acceptable bread formulations with blends of corn and wheat flour may also be possible, thus reducing the dependence on imported wheat and lowering the cost of bread. A major current concern about corn is the high prevalence of aflatoxin contamination (mold toxin).

Rice

Most rice is produced on large-scale technologically advanced farms in Costa Rica. In 1973, 70 percent of the production was from farms of 100 hectares or more which constituted only 10 percent of the total number of farms growing rice. In 1973, 14,347 rice farms - about 45 percent of all rice farms - were under 20 hectares in size and produced less than 20 percent of the rice crop. The number of smaller farmers growing rice has increased in recent years due to high guaranteed prices and to special credit programs.

Rice production is mainly on the Pacific side of the country with about 45 percent of the land in rice and 40 percent of the production being in the Pacifico Seco region during 1973. Another 26 percent of the land area in rice and 27 percent of the production was in the Pacifico Sur region. A sub-region of high yields in Parrita-Quepos which had only 17 percent of the land in rice but 27 percent of the production in 1973.

Total land area devoted to rice has increased rapidly in the last quarter century growing from 22,999 hectares in 1950 to 65,458 hectares in 1973. Average yields during that period increased from .82 MT to 1.59 MT per hectare.* Thus, total production of rice was 18,919 MT in 1950 and 104,009 MT in 1973.

Because of the economic incentives encouraging rice production, the land area devoted to rice as well as the yields are expected to increase even further. A CNP study projects land area devoted to rice by 1985 will reach 105,380 hectares and yields will be 2.81 MT per hectare. This is a 60 percent increase in land area and a 75 percent increase in yield over 1973 for a total estimated production of 296,366 MT nearly a tripling of 1973 production.

Although the population is projected to increase some 25 percent by 1985 and per capita rice consumption is projected to increase from about 75 pounds (milled basis) in 1973 to 77.3 pounds, the total domestic consumption is projected to increase from about 68,000 MT (milled basis) in 1975 to only 91,581 MT in 1985. Thus, assuming a 72 percent milling rate, the projected production of milled rice in 1985 will be 213,384 MT (296,366 x .72) or more than double the domestic requirement. Therefore, even though Costa Rica has been a net exporter of rice in recent years, if projections to 1985 are valid, exports of rice will need to be increased rather dramatically.

A number of problems have beset the rice industry in recent years, primarily due to lack of infrastructure for the rapidly rising production. In addition, the 1976 crop which had been forecast at 115,000 MT (milled basis) is now forecast to be only 42,000 MT. This is because of a 60 percent reduction in harvested area and reduced yields on the remaining area due to severe drought and disease problems. Nevertheless, even if projections to 1985 have to be revised downward, it would seem that GOCR rice policies will result in exportable surpluses in most years. In this case, rice could be used in a composite flour program to save on foreign exchange and possibly to reduce the cost of wheat foods.

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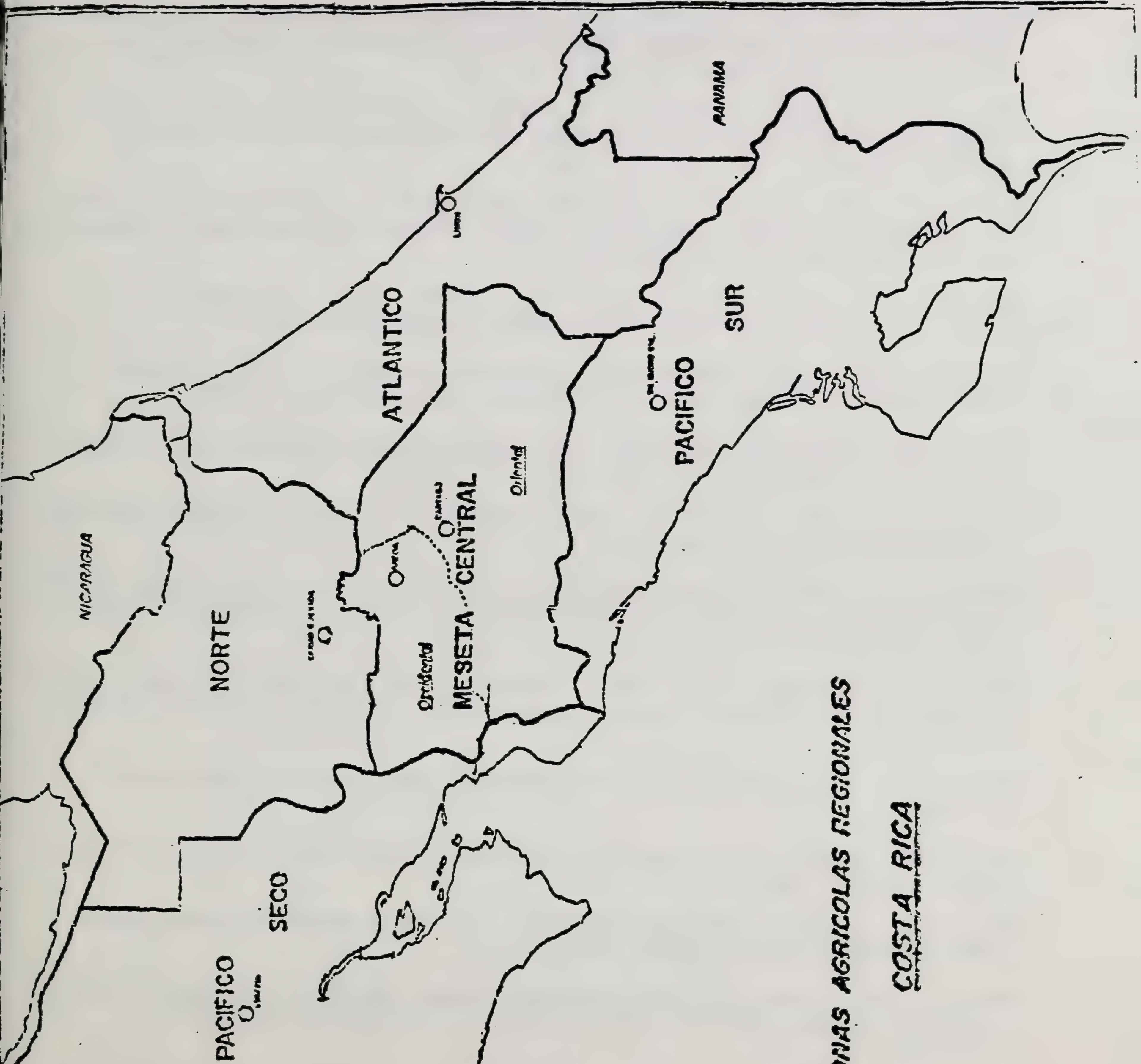
* All figures for rice are rough rice basis. (paddy) unless otherwise specified.

Given the current wholesale prices of wheat flour at 128 colones per 100 pounds and second grade milled rice at 121.50 colones, the use of second grade rice for producing flour to blend with wheat flour would offer only the foreign exchange advantage. This is so even though milling rice into flour would require only fine grinding and would be minimal in cost, the additional cost of packaging would result in a higher cost than wheat flour. If the exportable surplus were great enough, however, the finer broken rice (puntilla) currently selling for 70 and 80 colones per 100 pounds, depending on fineness, would be available in significant quantities and could be ground into flour at prices considerably lower than for wheat flour.

Assuming that the 1985 projection of rice production is valid and that 3 percent of the rice (rough basis) would be recovered in the form of puntilla, there would be 8,890 MT of puntilla (296,336 x .03) available for making into rice flour. If per capita wheat use remained the same during that period and population increased 25 percent, total wheat use would reach 100,000 MT. With a 67 percent extraction rate, this would be 67,000 MT of flour. Thus, at that time, low priced rice flour could be added to the entire wheat flour supply at a rate of up to 13 percent if desired. Such a program could be developed gradually to ease the transition but, as with other composite flour programs, would have to be evaluated for consumer acceptance before a final judgment regarding its feasibility could be made.

Rice flour has been used successfully in Japan and other Asian countries to extend wheat flour. Excellent bread products were made in Colombia under the UN-Netherlands-Colombian Interpan project (using 27% rice flour, 3% soy and 70% wheat flour). Definite possibilities are apparent for Costa Rica.

APPENDIX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NORTE
PACIFICO SECO
ZONAS AGRICOLAS REGIONALES
COSTA RICA

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PEOPLE CONTACTED DURING ASSESSMENT TRIP TO COSTA RICA

U.S. Embassy
- Edwin I. Cissel, Agricultural Attache
- Roy McDonald, Asst. Agricultural Attache

U.S. AID
- Ana Sayagues, Program Officer
- James Hawes, Rural Development Officer
- James Murphrey
- Larry Boone
- Robert Stickney

CARE
- Kurt Bachmann
- Ronnie Badilla
- Mary Ann Anderson

PAHO/UN
- Dr. Luis Jorge Osuna

GOVERNMENT OF COSTA RICA

Office of the President
- Rene Castro H.

Ministry of Agriculture
- Abel Coto

Ministry of Economics, Industry and Commerce
- Rene Sanchez B.
- Sr. Danilo

Ministry of Health
- Juan Carlos Antillon
- Carlos Dias Amador

Consejo Nacional de Produccion
- Roberto Jimenez
- Jose Fabio Zamora D.
- Orlando Jimenez

University of Costa Rica

CITA
- Dr. Luis Fernando Arias
- Ing. Jose Gonzales V.

INISA
- Dr. Leonardo Mata

Dept. of Agronomy
- Dr. Ronald Eschandi Z.

Industry

Nicholas Sanchez, Pan American Standard Brands

Ernesto Ruiz Aviles, C.R. Association for the Food Industry

Industry continued:

Roberto Calderon, Panaderia Roca

Franco Pacheco Musmanni, Panaderia Musmanni

Joseph Schmidt, Panaderia Schmidt

Enrique Cordero, Pastas Alimenticias Roma

Frank Jirik, Soy processor

Severino Pontigo D.,Molina de Costa Rica, S.A.
Enzo Prearo, Molina de Costa Rica, S.A.

Asdriebal Hernandez, Arrocera Costa Rica, S.A.
Felipe Palomo, Arrocera Costa Rica, S.A.

Gerardo Badilla, Industrias Las Palmas, S.A.

Carlos Hernan Bolanos L., Proajo, S.A.

Gaston Peralta, Procesadora San Carlos

Roberto Adolfo Loria, United Brands

Lic. Alfredo Fernandez, Gerbers Alimentos Infantiles

Guatemala

INCAP

Dr. Ricardo Bressani
Dr. Mario Molina
Dr. Delia Navarrette
Mr. Jesus Salazar
Dr. Robert Klein
Dr. A. Lechtig
Dr. R. Martorell
Dr. V. Valverde
Lic. Marina Flores
Ing. Juan del Canto
Dr. Guillermo Arroyave
Dr. F. E. Viteri
Dr. Juan Urrutia

ICAITI

Dr. Francisco Aguirre
Mr. Ricardo Garcia
Miss Elizabeth Orellana G.

U.S. ROCAP

Dr. Donald Feister
Mr. Larry Heilman

Appendix A-2

Proposed Project

Costa Rica

Protein Source: Wheat Protein Concentrate and/or full fat soy flour

Wheat Vehicle: Flour (Galletas and pasta)

In Country Project Expediter:

Individual: Dr. Luis Fernando Arias, Director

Organization: Centro de Investigaciones en Tecnologia de Alimentos (CITA), University of Costa Rica, San Jose

Mechanism of Distribution for Fortified Product(s): See attached chart.

Next Steps:

1. Obtain agreement with CITA on objectives of project and develop plan of cooperation.
   a. Development of galletas and pasta using WPC and/or full fat soy Nutritional guidelines.
   b. Establishment of WPC production at Molinas de Costa Rica. Quality guidelines.
   c. Acceptance testing of WPC and/or soy containing products. Nutritional Evaluation.
   d. Assistance to pasta and galleta manufacturers; packaging considerations.
   e. Utilization monitoring.

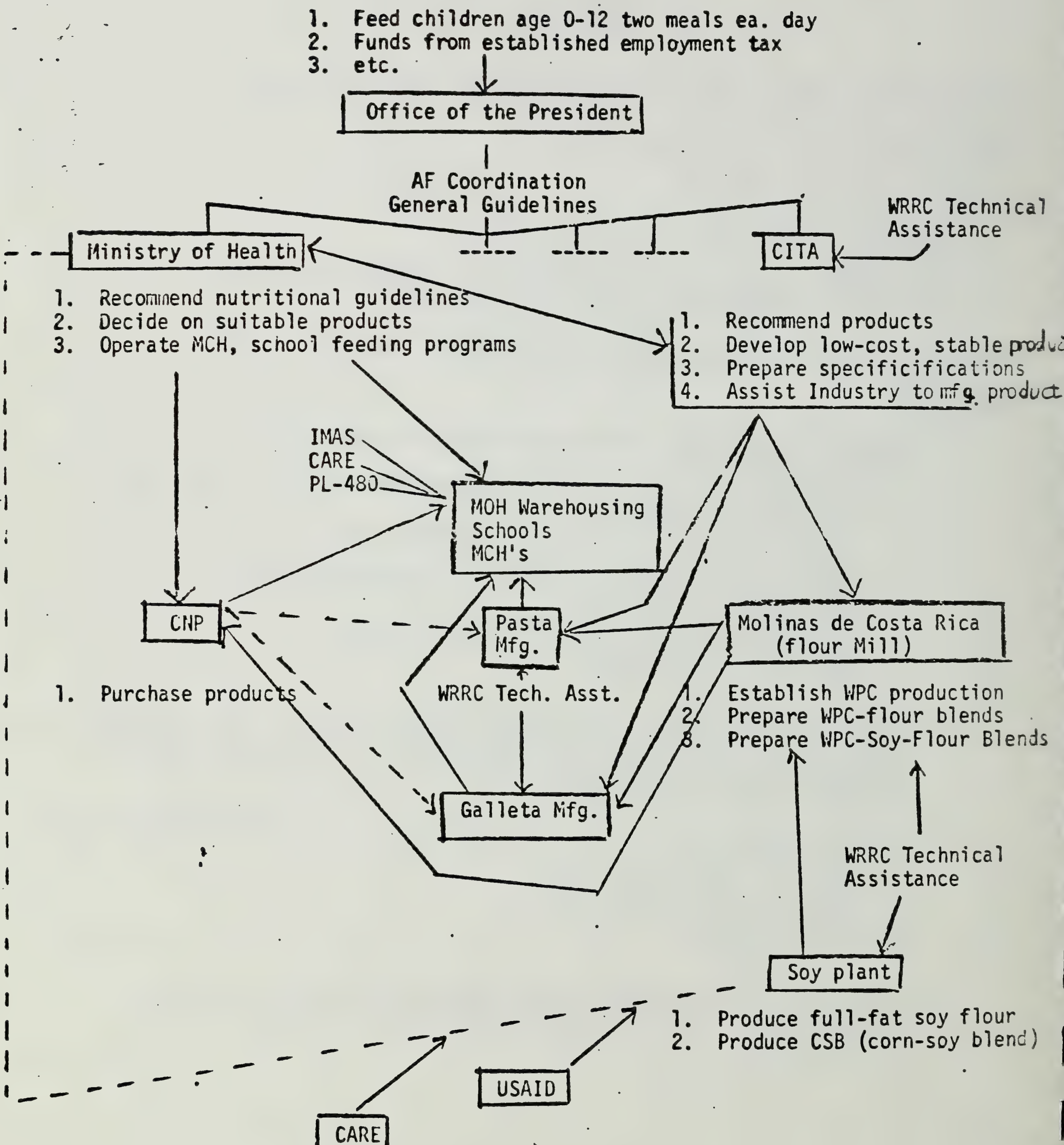
2. Obtain agreement (letter of intent or understanding) of the Asignaciones Familiares in the Office of the President and the Minitry of Health that WPC and/or soy fortified pastas and galletas are appropriate for the program and will be purchased.

3. Obtain agreement with Molinas de Costa Rica to establish WPC production/ and Blending capacity.
   a. Equipment needed.
   b. Capitalization of equipment.
   c. Guaranteed market for WPC.
   d. Quality control.
   e. Cost of WPC.

4. Coordinate with Colorado State University, CITA and MOH on quality requirements for full fat soy flour for anticipated uses in pastas and galletas.

Appendix A-2

Legislated
Asignaciones Familiares Program



Appendix A-2

The Case for Costa Rica
Background Information

Costa Rica is a Central American country boarded on the north by Nicaragua and on the south by Panama. Its population of 2 million is quite homogeneous and practicing the cultural patterns of the West. It has an elected representative government that has been particularly progressive in education (89% literacy) and social welfare. Private industry thrives in Costa Rica but the food sector, at least, currently feels somewhat on the defensive in light of expanding socialistic programs (there is the threat that the government will expand its own food processing, marketing and distribution systems). The recent legislation establishing the Social Development and Family Assistance program (Asignaciones Familiares), well funded by an employment tax, is an aggressive attempt to improve nutrition, health, sanitation, and welfare of the more disadvantaged element of the population especially in the rural areas. The feeding segment of the program attempts to provide 2 meals per day to all children age 0 to 12 in need thus providing an excellent opportunity for introducing fortified foods into a developing comprehensive distribution and feeding system.

NUTRITIONAL STATUS

Life expectancy of 69 years and infant mortality of 37/1000 live births indicates a good state of nutrition and health.

However, protein calorie malnutrition exists in Costa Rica and is most prevalent among the rural population. The magnitude and severity of the PCM problem depend on the method used to evaluate the data. PCM has been reported to affect more than 50% of the children less than 5 years of age when the Gomez classification scheme and Iowa standards are used, and slightly less than 13% (within Centers for Education and Nutrition) if stunting and wasting are used with the NAS Reference Population Standards.

Several dietary surveys of young children show that calories are generally more limiting than protein, but that protein is also often below recommended intakes. Data from some of these surveys is shown in Appendix A. If calories are, then, the most limiting macronutrient, this suggests that dietary supplements would most logically provide a larger proportion of the caloric than the protein requirement. High caloric supplements and/or larger quantities of the diet are two methods of approaching the problem. The latter might be substantially enhanced if lower cost foods were available.

In the area of micronutrients, problems exist as to the adequacy of iron, iodine, Vitamin A, riboflavin, thiamine, niacin and folate. Salt is iodized - 1972; Sugar is Vitamin A fortified - 1975; flour is fortified with thiamine, riboflavin, niacin and iron.

WHEAT SITUATION

All wheat is imported (80,000 MT) and is of high quality (HRS 75%, HRW, Durum, WW; mainly from the US). It is all milled (70% extraction) and enriched (B_1, B_2, B_3, F at one modern mill. Per capita disappearance of wheat is 90 lbs./year. On the order of 75% is consumed as bread manufactured in 6 large bakeries and hundreds of neighborhood bakeries. Pasta consumption is 15% of total wheat. Crackers (galletas), cakes, home flour use, etc. make up the remainder. Flour prices, fixed by the government range from 14 to 20¢ per lb. The major small bakery product is a roll (bollito) 25.5g and with a fixed retail price of 1.8¢. Large bakeries produce pan bread (400-500g loaf) that sells at 48¢. Distribution reaches all major cities and towns. 400 to 500 g of bollitos would sell at 28 to 35¢ thus is the product most likely to reach the more disadvantaged groups. Galletas and pastas offer the decided advantage of storage stability for a feeding program and in addition are currently priced such that per unit of dry weight, the cost is close to that of bollitos.

PROTEIN SOURCES

Soybeans: Production and processing of soybeans is experimental in Costa Rica (CARE and GOCR). The Ministry of Health (MOH) is contracting for the building and operation of a small plant to process 2 million lbs CSB and 0.6 million lbs full fat soy flour by the Brady Crop Cooker in 1977 from planned domestic soy production. Costs for soy flour are not known for Costa Rica but indications point to a substantially higher cost than wheat flour -- perhaps twice as much. Black beans are 27¢ per lb retail and it is doubtful that farmers would grow soybeans at a farm price less than blackbeans. The 0.6 million lbs of full fat soy flour is to be used in fortifying foods for the GOCR's feeding programs but which foods has not yet been decided. CITA (Food Research Center), Univ. of Costa Rica is doing product development work in this area.

Wheat Protein Concentrate (WPC): The further dry processing of the wheat millfeeds (24,000 MT) could extract an additional 2 to 5% of the total wheat yielding 1,600 to 4,000 MT of WPC (protein content is 20%). Based on current millfeed prices, estimated production cost, and diminished value of the residual millfeed, WPC might be made available for as little as 8 to 10¢ per lb compared to 14 to 20¢ per lb for standard white flours. A WPC fortified white flour would yield a lower cost more nutritious blend. Acceptance of products made from such blends is the critical aspect.

STARCHY EXTENDERS FOR COMPOSITE FLOURS

Rice: Production has surged ahead in recent years to self-sufficiency with indications for substantial further gains. Second grade rice (milled) at 14¢ per lb is about the same as wheat flour. Puntilla (very small brokens), however, is priced at 8 to 10¢ per lb and might make a suitable low cost extender for wheat flour. Based on current normal production of about 100,000 MT (milled basis), 3000 MT of puntilla might be available for a composite flour program.

Corn: Corn is currently imported in substantial quantities. With the costs of dehulling and degerming, corn flour would be priced in the same area as wheat flour, about 15¢ per lb.

Yuca: Yuca is an export crop and apparently more could be grown. It appears sufficient yuca flour (3,000 MT) is available at a price slightly below wheat flour to add 5 or 6% to all wheat flour. Analysis of a single yuca flour indicated a need to improve the sanitation in the process to reduce the heavy microbial population noted and improve wholesomeness. The use of yuca flour, which has only 1 or 2% protein, would lower the protein content of any composite flour. It appears the GOCR is keen on increasing the domestic utilization of yuca and has proposed addition of yuca flour to wheat flour --- 20% at first but suggesting 3% more recently.

INCOUNTRY ORGANIZATIONS

CITA: Food Research Center, University of Costa Rica. This is a relatively new center with an excellent pilot plant including a pasta extruder. Dr. L. F. Arias, Director is a politically astute leader maintaining good relations with both industry and government sponsors. CITA has been given responsibility to develop and improve low cost products for the Social Development and Family Assistance program. Dr. Arias has travelled in South America for the purpose of surveying the composite flour situation for GOCR. Mr. Jose Gonzalez (speaks excellent English) is a Food Technologist trained at Florida State University. He's had extruder training at Meals for Millions, California and experience using the Brady Crop Cooker in Costa Rica. He's experimented with composite flours for bread, pastas, and galletas using such ingredients as soy, WPC, corn, rice and yuca.

CARE: This voluntary agency has extensive feeding programs at CEN's and is additionally involved with AID in development of soy production, processing (Brady Crop Cooker) and utilization.

Molinas de Costa Rica: This modern mill of 7,500 cwt capacity appears to have good technical capability and should thus be able to rapidly assimilate a new WPC process and blending operation. The mill has a good quality control laboratory.

Pasta and Baking Industries: There are many private companies from large to small, from sophisticated to simple. Roma Prince, a subsidiary of the US company, has soy fortified pasta technology. In the baking area, sophistication is shown by the presence of whole wheat, sour rye, fiber bread and other difficult to produce bread types.

Appendix 1

Table 1. Analysis of the diets of preschool Costa Rican children in relation to deficiency of protein and calories

(1966 INCAP Study)

	Adequate in Calories	Deficient in Calories	Total
Adequate in Protein	12.8%	43.6%	56.4%
Deficient in Protein	1.3%	42.3%	43.6%
Total	14.1%	85.9%	100.0%
(1974 San Ramon Study)			
Adequate in Protein	24.5%	43.7%	68.2%
Deficient in Protein	0.0%	31.6%	31.8%
Total	24.5%	75.5%	100.0%

Reference: Valverde et al., (1975)

Table 2. % Adequacy of diets of rural Costa Rican preschoolers

Nutrient	Socioeconomic Status Low	Medium	High
Calories	64	78	83
Protein	85	121	148

Reference Menchu et al., 1973

Table 3. Dietary intake by 24 hour recall of Costa Rican children (12-66 mons) by number of CEN Meals Consumed

	Calories	Protein (g.)	% INCAP RDA[1/] Calories	Protein	RDA Calorie Gap
No meals at CEN	1033	31.0	59.0	93.9	717
Lunch at CEN	1198	40.0	68.5	123.9	552
Breakfast & Lunch at CEN	1495	53.0	85.4	160.6	255
Total (with and without meals at CEN)	1203	39.7	68.7	120.3	547

1/ INCAP RDA: 1750 calories, 33 g. Protein/day 4-6 yr. old

Reference: Anderson et al., 1976

* NPU = Net Protein Utlization

IMPROVING THE NUTRITIVE VALUE OF WHEAT FOODS IN COSTA RICA

I. INTRODUCTION

This project is established by the Western Regional Research Center (WRRC), United States Department of Agriculture, operating under the auspices of the Agency for International Development, Costa Rica (USAID/Costa Rica). Under AID PASA Agreement No. 931-11-560-231-73-3168048, entitled "Improving the Nutritive Value of Wheat Foods", AID provides funds to WRRC for the utilization of protein and general fortification technology in the improvement of the nutritional quality of wheat foods. This present project is designed to assist the Government of Costa Rica and CARE/Costa Rica in the implementation of soy protein technology for the incorporation of full fat soy flour into wheat foods. This goal will be met through the coordinated and cooperative effort of WRRC assisting USAID/Costa Rica, the Government of Costa Rica (GOCR) through the Centro de Investigaciones en Technologia de Alimentos (CITA) and segments of the private sector.

II. PROJECT PURPOSE AND OBJECTIVES

II.1 Purpose

The purpose of the project is to improve the nutritional well-being of the people of Costa Rica through the following mechanisms.

II.1.1. Provide technical assistance to GOCR and CARE/Costa Rica for utilizing full fat soy flour (FFSF) produced through the CARE Operating Grant Program.

II.1.2 Implement soy protein technology in the development and production of fortified wheat foods for use in the GOCR feeding programs.

II.2 GOALS

The following goals will be attained in reaching the project purpose.

II.2.1 Development of pasta and/or bread products containing FFSF for use in Asignaciones Familiares Program or other GOCR feeding programs.

II.2.2 A minimum increase of 20% in the protein content of the "composite flour material" used in the preparation of the above products.

II.3 PROJECT PHASES

II.3.1 First Phase: Development of suitable formulae and production technique for the manufacture of soy-fortified pasta, and application of currently developed soy protein technology to the incorporation of FFSF into fortified bread and rolls.

11.3.2 Second Phase. Finalization of large-scale manufacturing procedures for pasta and bread and conducting distribution and acceptability tests.

II.3.3 Third Phase. Initiation and continued large scale manufacture of fortified products for GOCR use in feeding programs. Supply of FFSF assured by GOCR through CARE manufacturing facility regardless of source of soy beans; viz., locally grown soybeans would be supplemented with imported soybeans if necessary.

II.4 ACTIVITIES

II.4.1 First Phase. Technology Transfer and Process Development.

II.4.1.1 Conduct tests at CITA to develop a suitable formulation and production procedure for acceptable fortified pasta and/or crackers containing FFSF.

II.4.1.2 Apply soy fortification technology to the production of acceptable bread and rolls fortified with FFSF. Pilot baking trials to be carried out at CITA and/or WRRC using FFSF representative of the standard quality to be produced in the CARE facility.

II.4.1.3 Pilot scale production of nutritionally improved pasta and/or crackers will be done at CITA in preparation for commercial production trials.

II.4.1.4 Carry out shelf-life (storage) tests of duration commensurate with the products characteristics and intended use pattern and determine distribution techniques to be used.

II.4.2 Second Phase. Commercial Production Trials.

II.4.2.1 Carry out large-scale production trials of fortified wheat foods in a commercial enterprises bakery using CARE produced FFSF in order to evaluate procedures and the quality of fortified product. Produce sufficient quantity for pilot distribution of product through selected Asignacione Familiares Program channels.

II.4.2.2 Determine acceptance of above products through recipient comments and evaluations. Make adjustments in formulation or procedures as necessary to produce acceptable fortified products.

II.4.2.3 Review the adequacy of packaging and storage conditions of FFSF and finished fortified products and adjust if necessary.

II.4.2.4 Complete economic analysis of manufactured cost of each fortified product.

II.4.2.5 Participate in LEC Workshop in October 1978 by demonstrating fortified products and reporting on production techniques and cost analysis.

II.4.3 Third Phase. Commercial Manufacture and Distribution.

II.4.3.1 Determination by GOCR official of the number and location of production facilities needed to provide the required quantities of fortified products.

II.4.3.2 Special assistance provided through WRRC and CITA for training plant personnel of selected facilities in the production techniques for fortified products.

II.4.3.3 Development of final plans for distribution of fortified products to recipients in the Asignacione Familiares and other GOCR feeding programs.

III. PROJECT SETTING AND BACKGROUND

III.1. NUTRITIONAL SITUATION

Life expectancy of 69 years and infant mortality of 37/1000 live births indicates a good state of nutrition and health. However, protein calorie malnutrition exists in Costa Rica and is most prevalent in the rural population. The magnitude and severity of the PCM problem depend on the method used to evaluate the data. PCM has been reported to affect more than 50% of the children less than 5 years of age when the Gomez classification scheme and Iowa standards are used, and slightly less than 13% (within Centers of Education and Nutrition) if stunting and wasting are used with the NAS Reference Population Standards.

Several dietary surveys show that calories are generally more limiting than protein, but that protein is also often below

recommended intakes. A high caloric supplement such as FFSF provides additional quantities of both calories and protein.

III.2 WHEAT SITUATION

All wheat is imported (80,000MT) and is of high quality, mainly from the United States. It is all milled (70% extraction) and enriched (B1, B2, B3, Fe) at one mill, Molinos de Costa Rica. Per capita consumption of 90 lbs/yr., wheat, or 63 lbs/year, flour. Approximately 75% of flour is consumed as bread manufactured in 6 large bakeries and hundreds of neighborhood bakeries. Pasta is approximately 15% of total wheat, and galletas, cakes, home flour, etc., make up the remainder. The major small bakery product is a roll (bollito), and at a fixed low retail price, presumably is the product most likely to reach the more disadvantaged groups. Pastas made under an existing low-priced flour structure would also reach the latter groups. Galletas and pastas, in contrast to bread, offer the advantage of storage stability for a feeding program.

III.3 Protein Source

The production and processing of soybeans is at a crucial stage in Costa Rica. The GOCR has contracted to purchase the 1977 crop which is being produced under direct CARE supervision estimated at 200-300MT and with the 1976 crop in storage (300MT), all of which are targeted for the GOCR feeding programs. The building of the CARE/OPG processing facility is almost completed, and installation of all food-grade processing equipment is expected to be completed by June 1978. Processing of soybeans in this installation will be

contracted to a commercial enterprise (ProNutre). During 1978 it is anticipated that 1000MT of corn soy blend and 150-300MT of FFSF will be produced on the Brady Crop Cooker. Costs for the FFSF are estimated to be U.S. .28¢/lb, based on CR soybeans and cost to plant of U.S. .21¢lb. All of the end products will be used only in the GOCR feeding programs.

III.4 Organization Inputs

III.4.1 WRRC under the PASA Agreement with AID, has prepared two reports as a result of an assessment team visit in October 1976: "Potential for Protein Fortification and Extension of Wheat Foods in Costa Rica" and "Case for a Wheat Flour Fortification Program in Costa Rica."

III.5.2 CARE has an Operational Program Grant (OPG) with AID, No. 515 which provides for the installation and operation of a plant to make corn-soy blend (2,000,000 lbs. per year) and FFSF (600,000 lbs. per year). The Grant terminates September 30, 1979. In the event that it is not feasible to produce adequate supplies of soybeans in Costa Rica, the GOCR will import a sufficient quantity for processing in the CARE facility to produce the FFSF protein supplement needed for the fortified foods used in the feeding program.

IV. COURSE OF ACTION

IV.1 Project Development Strategy

The project is divided into three phases, 1) Technology Transfer

and Process Development, 2) Commercial Production Trials, and 3) Commercial Manufacture and Distribution. WRRC will work in close cooperation with CITA and CARE/Costa Rica in regards to the GOCR feeding programs. It is anticipated that phase I will be relatively short and will be completed within 4 months. The remaining two phases will be completed within 12 additional months if the CARE plant is operational within the schedule cited above. The result of the coordinated development and commercial production capability will be improvement in the nutritional well-being of the people of Costa Rica.

IV.2 Costa Rica Organizations

IV.2.1 GOCR (CITA) Organization:

CITA is the GOCR organization given the responsibility of advising the GOCR which types of nutritionally-rich materials should be purchased under the Asignaciones Familiares program.

Personnel:	Ing. Luis Fernando Arias
	Jose Gonzalez, B.S.
	Ir. Marga Cordes
	Ing. Horacio Vargas
Equipment:	Braibanti pasta extruder
	Braibanti pasta drying cabinet
	Ovens
	Controlled relative humidity chamber
	Fitz colloid mill
	Mixers, balances, Tyler Sieves, etc.

Access to:	Farinograph, Amylograph, Extensograph
	(Commercial: Molinos de Costa Rica)
Physical Facility:	Modern laboratories and pilot plant

IV.2.2 CARE/USAID Organizations

Personnel:	Ms. Ana Sayaguez, AID Acting Project Officer
	Mr. Kurt Bachmann, CARE Director
	Mr. Ronnie Badilla, Assistant CARE Director
	Ing. Juan Antonio Piedra, CARE engineer
	Colorado State University (CSU) personnel involved in CARE/OPG
Equipment:	Brady Crop Cooker
	CSU Hot-bed roaster
	Alpine pin-mill
	Hammer mill
	All auxilliary equipment for production of food-grade FFSF
Physical Facility:	Modern plant with storage facilities, etc.

IV.2.3 Supporting Parties

IV.2.3.1 GOCR through overall involvement of Ministries of Agriculture and Health's participation in development of soy production capability on providing of soybeans to process and commitment to purchase FFSF during 1978, and until September 30, 1979 for their feeding programs as part of the CARE/OPG.

IV.2.3.2 A commercial bakery has verbally agreed to process sufficient quantities of bread and rolls, for acceptability testing and for developing an economic evaluation, to be carried out in the Second Phase.

IV.3 WRRC Organization

IV.3.1 WRRC is a large agricultural research center funded and operated by the United States Department of Agriculture. It is located at 800 Buchanan Street, Albany, California 94710, U.S.A. WRRC has entered into a Participating Agency Service Agreement (PASA No. 931-11-560-231-73-3168048) with the Technical Assistance Bureau, USAID/Washington wherein funds made available by USAID are to be used by WRRC to implement two projects around the world on "Improving the Nutritive Value of Wheat Foods." The PASA was signed in June 1976 and extends through April 1979, but can be extended to September 30, 1979.

IV.3.2 Permanent WRRC staff assigned to this project: a) Dr. Robin M. Saunders, Manager Costa Rica Project, and Food Technologist, b) Dr. David Fellers, Food Technologist, c) Ms. Maura M. Bean, Baking Technologist, d) Dr. Antoinette A. Betschart, Nutritionist, e) Mr. Robert V. Enochian, Agricultural Economist and Market Specialist, f) Mr. Allan D. Shepherd, Food Technologist, g) Mrs. Virginia Nelson, Secretary. The PASA provides funds for the salaries, travel and per diem of the WRRC staff.

IV.3.3 Consultants. The PASA provides separate funds for the hiring of consultants to complement the WRRC expertise. Consultants will be selected when deemed necessary by WRRC.

IV.3.4 WRRC laboratory capabilities. The laboratories of WRRC are staffed by more than 150 senior scientists, plus technical and staff support, and have extensive capabilities pertinent to this project. These include a complete baking laboratory, pilot plants, and facilities for physical, chemical, microbiological and nutritional analyses. Those facilities will be utilized only when deemed necessary by WRRC.

IV.3.5 Direct Overseas Expenditures. The PASA provides separate funds for use in Costa Rica to provide minor equipment, ingredients, services and contracts as deemed necessary by WRRC and agreed to by AID/W, but subject to the legal restrictions otherwise in effect by the GOCR, U.S. Government or bilateral or international treaties.

IV.4 FINANCIAL OBLIGATION

IV.4.1	WRRC personnel, 6 part time	$ 70,000
IV.4.2	Travel and per diem	20,000
IV.4.3	Consultants	15,000
IV.4.4	WRRC overhead to include use of laboratory facilities, supplies, etc.	45,000

IV.4.5 Direct overseas expenditures $ 50,000

a) Equipment*

b) Raw Materials*

c) Services and rentals*

d) Equipment (commercial sector)*

e) Contracts*

* To be determined as project progresses.

IV.4.6 Total cash or equivalent obligation 200,000

(¢1,708,000)

IV.5 IMPLEMENTATION PLAN

A PERT chart is attached which summarizes the following events necessary for successful project implementation.

IV.5.1 Schedule of Events

First Phase: a) Prepare Project Outline and obtain approval by USAID/Costa Rica, GOCR and CITA; b) Purchase, ship and install equipment needed at CITA for appraisal studies on FFSF-fortified wheat foods; c) Obtain additives such as dough conditioners for composite flour formulation work and testing; d) Develop and test composite flour formulation(s) by physical, chemical, nutritional, microbiological and rheological means, and by baking and pasta preparation. Optimum FFSF incorporation is chosen by considering a balance of nutritional, functional, and organoleptic quality, industrial feasibility, cost, soy supply and potential; e) Prepare specifications for the FFSF fortified wheat food(s) considered

acceptable; f) Store sufficient quantities of fortified foods under conditions amenable for their demonstration and appraisal to interested parties at a later date; g) Evaluate the work of the first phase and prepare a report.

Second Phase: h) Procure FFSF produced in CARE facility and use in final pilot tests and for commercial tests to follow; i) Carry out large-scale production trials for the preparation of FFSF fortified food(s); j) Determine acceptability of products through limited distribution and use in Asignacione Familiares or other feeding program channels; k) Demonstrate finished products and report on production, distribution, nutritional benefits and cost analysis at LEC Workshop in October 1978.

Third Phase: l) Preparation of manufacturing facilities selected by GOCR for production of fortified products; m) Training of production personnel in selected plants in the manufacture of fortified products; n) Start-up of commercial production and distribution of fortified products on a continuing basis; o) Initiate program of public information and nutrition education on nationwide basis regarding fortified foods; p) Explore with GOCR and CARE officials the possibilities of making available to the private sector FFSF or fortified products for use as low-cost nutritionally improved foods for that portion of the population not recipients of a feeding program.

IV.6 EVALUATIONS

IV.6.1 Phase one will be evaluated by its timely meeting of target dates

for pilot production of acceptable quality fortified foods prior to regular production of FFSF in the CARE facility.

IV.6.2 Phase two will be measured by the satisfactory demonstration of continuous production of fortified foods on a large enough scale to meet the requirements of the GOCR feeding programs.

IV.6.3 Phase three and the entire project will be analyzed for success by the continued production and use of wheat foods fortified with FFSF for the final six months of the project time frame and more especially the recorded quantities of fortified foods containing FFSF produced and distributed will be a quantitative measure of the extent of success.

V. <u>SPECIFIC COMMITMENTS</u>

V.1 <u>Costa Rica Organizations</u>

V.1.1 CITA will provide physical facilities, required services such as electricity and water, and pay salaries of CITA personnel who cooperate during any phase of the project. They will also install equipment provided by WRRC which is considered essential for successful implementation of the project.

V.2 <u>WRRC/USAID</u>

V.2.1 Purchase and provide to CITA equipment necessary for the successful implementation of phase one in an amount not to exceed $10,000 including air freight.

V.2.2 Provide a baking technologist for up to one month to assist in R&D work.

V.2.3 Provide a pasta expert for up to one month to assist in R&D work.

V.2.4 Participate in LEC Workshop.

V.2.5 Provide support in the area of nutritional planning and in nutritional analyses of ingredients, composite flours and final products.

V.2.6 Provide a market research expert to assist in the design of marketing or distribution channels for finished products.

V.2.7 Provide an economist to evaluate economic viability of FFSF-fortification.

V.2.8 Provide a food technologist to assist during large scale manufacture of fortified bread and pasta.

V.2.9 At all stages of project, will consider short-term assignments of personnel to provide expert counsel on technological, nutritional, economic or managerial needs in order to successfully implement project.

POTENTIAL FOR PROTEIN FORTIFICATION OF WHEAT FOODS IN BOLIVIA

Report of Assessment Trip to Bolivia
February 19 - March 1, 1977

Project: Improving Nutritive Value of Wheat Foods

Conducted under WRRC-AID PASA #931-11-560-231-73-3168048

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SUMMARY STATEMENTS

1. The 1976 census, the first since 1950, showed the population of Bolivia to be about 4.7 million, some 16% less than recently estimated. As a result, most previous per capita data has been thrown into a state of confusion and are probably generally understated. The population is about 70% rural, 30% urban. Some 42% live on the Altiplano, 35% in the Valles and 23% in the Oriente and Yungas.
2. Agriculture accounts for 65% of the employed workers. It produced exports of U.S. $48 million in 1972, mainly cattle, meat, coffee, cacao, timber, cotton, sugar cane, wool and rice. Major domestic crops are potatoes, corn, vegetables, sugar cane, rice, yuca, cotton and wheat.
3. A sound base exists for planning and developing nutrition programs. This includes a recent GOB Five Year (1976-1980) Food and Nutrition Plan, a well defined infrastructure within the GOB for planning national nutrition strategy, and close cooperation between the GOB and USAID/Bolivia in the development of USAID Nutrition Strategy. USAID/Bolivia has recently completed Health, Nutrition, and Agriculture assessments.
4. The public health status is relatively poor. Infant mortality estimates range from 145 to 250 per 1,000 live births. A study of the cities of La Paz and Viacha showed 41 to 47% of under age 5 deaths were cases in which malnutrition and immaturity were underlying or associated causes.
5. Based on several consumption studies, average daily per capita consumption was 1870 to 1998 calories and 44 to 57.5 grams protein. Adjustment for the 1976 census suggests average availabilities of 2200 calories and 59 grams of protein. Low income groups consume substantially less than the averages. Valles inhabitants generally consumed more calories and protein than those on the Altiplano.

6. Protein-Calorie Malnutrition (PCM) among children, and anemia in pregant and lactating women are seen as primary nutritional problems, followed by iodine (goiter) and vitamin deficiencies. PCM appears to be more prevalent on the altiplano than in the tropical regions.
7. GOB defined target groups for nutritional intervention programs as those in rural areas, those less than 5 years of age, pregnant and lactating women, school children 5 to 15 years old, and marginal urban poor.
8. Per capita availability of wheat is about 110 lbs. per year. Between 200,000 and 230,000 MT of wheat is imported while 69,000 MT is produced domestically. About half the imports are as flour. Only 10,000 MT of domestic wheat is milled in the 12 large commercial mills. GOB intends to phase out flour imports by January 1, 1978. Accordingly, milling capacity is currently expanding rapidly. Bread, made in small shops by hand, is the major wheat product followed by pasta. Flour, 72% extraction, and bread prices are fixed by the GOB at U.S. $15/cwt and U.S. 2.5 cents for a 60 gram piece, respectively.
9. There is some composite flour experience in Bolivia including the incorporation of 5% quinoa in wheat flour (GOB 1975 decree), though at present implementation is limited to the Oruro area.

   Availability and cost of quinoa limit its expansion to other market areas. Soybean, corn and rice offer new sources for protein fortified and/or other composite flours in the near term. Animal grade soy meal is produced at SAO in Santa Cruz and at the GOB Villamontes plant. Solvent extraction is used. However, an adequate supply of soybeans is a major problem. Price of the soy flour may be another problem. Rice is now in surplus and the crop is expanding. The government agency, ENA, has spearheaded the development of strong rice production, drying, processing, storage and marketing infrastructures. Rice flour could be produced at the wheat mills. Price may be the major constraint

to rice utilization in composite flours. Corn flour processing capacity is very limited and the general marketing structure for corn and corn products is quite rudimentary, limiting extensive near term use in composite flours. A major advantage with corn may be its generally lower cost. The Santa Cruz Public Works Development Corporation has contracted research (Contec, Inc.) that showed the technical feasibility of blending soybean, corn and rice flours with wheat flour. The Agency of Standards and Technology, MICT, has a proposed composite flour development project and is equipped to carry out composite flour research, quality control and regulation. MACA and CID are carrying out economic analyses on composite flours.

ACRONYMS AND DEFINITIONS

ADIM	Asociacion del Industria Molineros
AID (USAID)	U.S. Agency for International Development
CBF	Corporacion Boliviana de Fomento
CELADE	Centro Latina America para Demographia
CID	Consortium for International Development
c.i.f.	Cost, insurance, and freight
CONEPLAN	National Council of Economy and Planning (Interministerial)
CWP (WPC)	Concentrated Wheat Protein (or Wheat Protein Concentrate)
cwt	Hundred weight (100 pounds)
DGNT	Direccion General Normas y Technologia, MICT
DPT	Diphteria, pertussis, and tetanus
ENA	Empresa Nacional del Arroz
FACSA	Fabrica de Aceites de Villamontes
FAO	Food and Agriculture Organization, UN
FNGT (GTAN, GTN)	Food and Nutrition Technical Group, Ministry of Planning and Coordination
f.o.b.	Free on board
GNP	Gross National Product
GOB	Government of Bolivia
ICNND	Interdepartmental Committee on Nutrition for National Defense
INE	Instituto Nacional de Estadisticas
MACA	Ministerio de Asuntos Campesinos y Agropecuarios
MICT	Ministerio de Industria, Commercio, y Tourismo
MPSSP	Ministerio de Prevision Social y Salud Publica

MT	Metric Tons
PAHO	Pan American Health Organization
PASA	Participating Agency Service Agreement
PASB	Pan American Sanitary Bureau
PCM	Protein-calorie malnutrition
PIA/PNAN	Proyecto Interagencial de Promocion de Politicas Nacionales de Alimentacion y Nutricion (1976-1980 Food and Nutrition Plan)
PL 480	U.S. Public Law 480; authorizes donation and concessional sale of U.S. commodities to other countries
quintal	100 pounds
SAO	Sociedad Aceitera del Oriente
UN	United Nations
UNICEF	United Nations Children's Fund
USDA	U.S. Department of Agriculture
WHO	World Health Organization, UN
WRRC	Western Regional Research Center, USDA - a food research laboratory located at Albany, California

INTRODUCTION

Population[1/]

In 1976 - the year of the last national census - the population of Bolivia was about 4.7 million people. The previous census, in 1950 had indicated a population of 3.0 million. Estimates since 1950 by the National Institute of Statistics (INE) had shown a much more rapid increase in population than had actually been occurring. In 1974, for example, the INE estimates had indicated a population of 5.5 million. Thus, the 1976 census will result in considerable adjustments in growth and welfare indicators, such a per capita GNP, food availability, projected population, etc. These adjustments have not yet been made, however, and except where indicated, per capita indicators throughout this report are based on population estimates made prior to the 1976 census and are, therefore, generally understated.

The annual rate of growth of the total population prior to the 1976 census was estimated to be about 2.7 percent. This would result in a doubling of the population every 25 years and a projected population of 6.5 million persons by 1980. These estimates probably are now overstated.

The country is divided into nine administrative departments but population distribution is frequently analyzed by ecologic regions and zones. There are four major regions in the country which are further divided into

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1/ The primary source of data in this section is Agricultural Development in Bolivia: A Sector Assessment, USAID Mission to Bolivia, (August 1974).

ten different ecologic zones. The four regions are the Altiplano with north, central and southern zones; the Valles, which is a single zone; the Yungas, another zone; and the Oriente which is divided into five zones: The Amazon Rain Forest, the Beni Plain, Santa Cruz, the Brazilian Shield, and the Bolivian Chaco (see Figure 1).

Estimates made in 1972 indicate that more than 42 percent of Bolivia's population resided in the north and central Altiplano on about 9.2 percent of the land area, and 35 percent of the people resided in the Valles on about 13.1 percent of the land area. The remaining 23 percent of the population was widely scattered over 77.7 percent of the land area. The regional and zonal distribution of both the urban and rural population of Bolivia in 1972 are shown in Table 1.

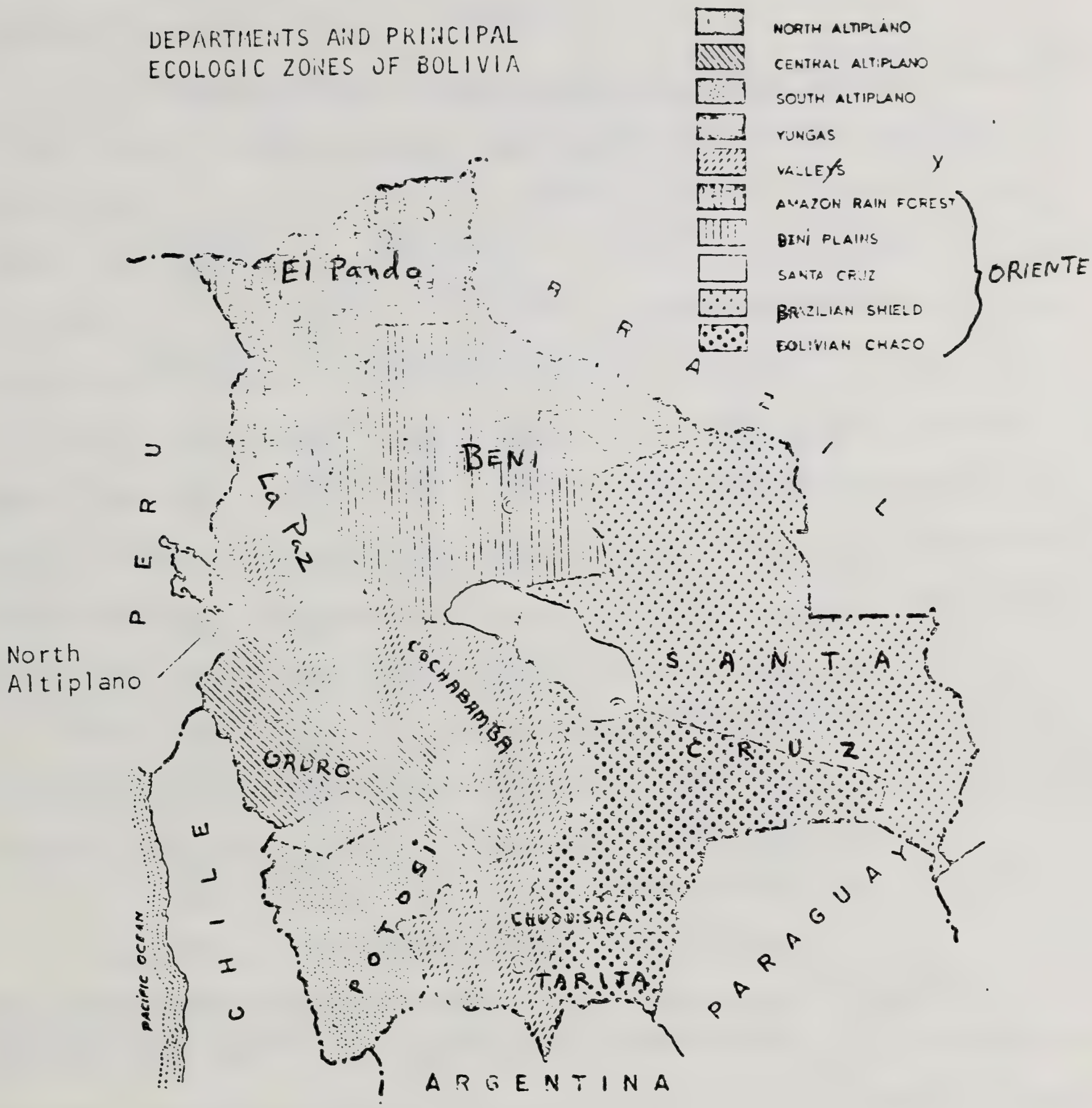
The rural population of Bolivia is currently estimated to be about 68 percent of the total. This is less than the 74 percent recorded in 1950 and more than the 61 percent projected for 1980. The majority of the rural population (78%) lives in the Altiplano and the Valles (Table 1).

There is some rural to urban migration in Bolivia but it is at a low rate and will not result in a significant shift in the relative location of the population in the near future. There also has been some migration from one rural area to another but this has not significantly altered rural population densities among areas. Most of this migration has been from the Altiplano and Valles to the sparsely populated Yungas and the Oriente.

Economic Situation

The gross domestic product of Bolivia in 1973 was estimated to be U.S. $1,075 million and was growing at a rate of 6 percent per year. On a per

Figure 1



SOURCE: Agricultural Development in Bolivia: A Sector Assessment, United States AID Mission to Bolivia, La Paz, August 1974.

Table 1

The Rural-Urban Composition of the Population

by Ecologic Zone, Bolivia, 1972

Regions and Zones	Population Urban	Population Rural	Population Total	Rural as a Share of Total
	----(thousand)-----			Percent
I. Altiplano	933	1,362	2,295	59
a) North	599	328	927	35
b) Central	303	954	1,257	76
c) South	31	81	112	72
II. Valles	425	1,386	1,811	77
III. Yungas	41	228	269	85
IV. Oriente	249	552	801	69
a) Amazon Rain Forest	26	106	132	81
b) Beni Plain	29	87	116	75
c) Santa Cruz	141	92	233	39
d) Brazilian Shield	17	92	109	84
e) Bolivian Chaco	37	176	213	83
Bolivia	1,648	3,528	5,176	68

SOURCE: Agricultural Development in Bolivia: A Sector Assessment, United States AID Mission to Bolivia, La Paz, August 1974.

capita basis, this is equal to U.S. $203 with a rate of growth of 3.5 percent per year (U.S. Dept. of State, 1974).

The growth of Bolivia's aggregate output has been sporadic. From 1952 to 1962, annual economic growth was mostly low and inflation was high. The average annual rate of growth in this period was about 0.1 percent. From 1962 to 1972, GNP increased at an annual rate of about 5.4 percent in response to monetary reforms, increased production of petroleum, improved prices for minerals, and a surge of agricultural activity in the Santa Cruz area.

The general cost of living has been rising steadily over the past several years and since 1972 has increased sharply, especially because of rapid increases in the prices for food. From mid-1972 to early 1974, the La Paz food price index doubled compared to the average annual rate of 5.5 percent from 1957 to early 1972 (USAID Mission to Bolivia, Aug. 1974).

Since 1950, Bolivia has faced a chronic balance of payments problem. In recent years, the situation has been more favorable as a result of increased petroleum and mineral prices and recent new discoveries of petroleum.

Importance of Agriculture

Agriculture is the main source of employment, a major source of domestic income and a large export earner. In 1971-72, about 22 percent of the gross domestic product was from agriculture. The most important crops in terms of farm value are potatoes, vegetables (sweet corn, onions, tomatoes, green peas), corn (grain) and sugar cane. Other major crops include yuca, rice, cotton, and wheat. These crops are produced mostly on small farms and a substantial part of the production is used for domestic consumption.

Livestock production is important in some parts of Bolivia but, with the exception of some dairy products, data series are poor or non-existent. Bolivia is self-sufficient in butter and dried skim milk but produces only small quantities of its whole milk requirements, most of which are imported in dried form. A serious constraint to greater milk production is lack of feed in the traditional areas of milk production. The success of efforts to put new lands into feed production and increase yields will determine whether milk production can be increased successfully in Bolivia.

Major agricultural export commodities from Bolivia are cattle and meat, coffee and cacao, timber products, and cotton. These commodities accounted for 80 percent of the agricultural exports in 1972. Agricultural exports amounted to U.S. $47.8 million in 1973 which was 13.7 percent of total exports. Almost all of the production of Bolivia's exports crops is in the subtropical lowlands of the oriente and yungas. While some export crops - coffee, sugar cane, wool, and rice - are important on small farms, the major share of export earnings are being generated on large commercial farms. Projections indicate that agricultural exports may grow at the rate of 15 to 20 percent annually over the next few years. Because most small farms are subsistence in nature and have a limited potential for increasing production in response to price incentives, any import substitution possibilities in the near future, as well as growth in agricultural exports, is likely to come from increased production on large farms (USAID Mission to Bolivia, Aug. 1974).

Historically, the overall agricultural trade balance of Bolivia has been negative. Imports consistently exceed exports in the agricultural sector by about U.S. $20 to $30 million each year. Food imports contribute significantly to the negative balance, with wheat and flour representing the largest share.

The total active work force in 1971-72 was estimated at 2,827,.... is about 55 percent of the population which indicates a large proportion of the population is under age 15. About 71 percent of this active work force was actually employed. Of the remainder, 14 percent were considered to be unemployed because they were seeking employment, while 15 percent were not employed but were not seeking employment. Of those employed, nearly 65 percent were employed in the agricultural sector. Employment projections indicate that by 1980 agricultural employment will decline slightly to about 62 percent of total employment.

Considerable unemployment and underemployment exists in the agricultural sector, especially among the small farmers of the Altiplano and Valles. This has resulted in an outmigration of agricultural labor from these areas. The limited capacity of the urban areas to absorb large numbers of unemployed is a strong argument for attempting to expand agricultural employment opportunities in areas which have a potential for agricultural development. An objective of Bolivia's agricultural development plan is to encourage migration of people to these areas from the Altiplano and Valles.

2/ The total active work force is that part of the population aged 15-64 that is capable of working.

NUTRITIONAL STATUS

Introduction

The nutritional status of a population is the result of the interrelationships between many factors including availability of food, nutritional adequacy of the diet, income and educational level, sanitation and public health status, disease patterns, and many others. Throughout this section of the report, it should be kept in mind that the diversity of the four major regions in Bolivia is expected to have an effect upon nutritional indicators. Whenever possible, data was sought which described nutritional status by these geographic regions.

The available nutritional data has been well summarized in the Five Year Food and Nutrition Plan (PIA/PNAN) (1976-1980) and the USAID/Bolivian Nutrition Sector Assessment (1976). Trowbridge and Haverberg (1977) critically reviewed the available data and analyzed various alternatives for data collection which Bolivia might consider in future studies. Those data and studies most relevant to a Wheat Fortification Project are discussed in this report.

The major limitation on data is that values for projected population have been overestimated. As a result of the 1976 census, the Bolivian population was found to be approximately 4.7 million (INE, Nov. 11, 1976) or 86 percent of the previous estimate of 5.5 million. The discrepancy was partially the result of not having census data since 1950, and estimating the annual growth rate at 2.6 percent when it appears to have been approximately 2.14 percent. Thus, analysis of food balance sheets, available calories and protein, on the basis of population, are difficult to interpret and underestimate the resources available per capita. Specific studies using anthropometric data and dietary recall would not be influenced by inaccuracies in population data.

Target groups, or those most nutritionally vulnerable, have been defined by various groups. The GOB, in its 5-year Food and Nutrition Plan, gives highest priority to the rural areas, those less than 5 years of age, pregnant and lactating women, and school children, 5 to 15 years old. USAID/Bolivia focuses its primary attention on infants and children, pregnant and lactating women, rural areas and marginal urban areas. Finally, the Division of Nutrition, Ministry of Social Welfare and Public Health (MPSSP) prioritizes the target groups the same as the GOB, except that it includes the marginal urban poor along with rural areas.

Protein-calorie malnutrition and anemia are described as the primary nutritional problems, followed by goiter and vitamin deficiencies (PIA/PNAN, 1976; USAID/Bolivia, 1976). The nature and severity of these deficiencies will be discussed as they relate to the Wheat Fortification Project.

Public Health Status

Nutritional and public health status are intimately interrelated. Available data relating to standard indices of public health in Bolivia are reportedly often educated guesses. USAID/Bolivia recently summarized much of the available public health information in its Health Sector Assessment (1975).

The public health status of Bolivia is one of the poorest of the Latin American countries. In response to this situation, USAID/Bolivia in cooperation with the GOB, is supporting sanitation and immunization programs in select areas of Bolivia.

Life expectancy, at birth, was 47 years in 1975 and projected to be 52 years by 1980 (PIA/PNAN, 1976). Crude mortality rate is estimated to be 18 to 19/1,000 population (CELADE, 1976; USAID/Bolivia, 1976). National average infant mortality figures and estimates range from 145 to 250/1,000 live births

(Table 2). The difficulties involved in obtaining accurate data may account for some of the differences reported. The data reported by the Latin American Center for Demography (CELADE, 1976) is the most recent. The survey, conducted in 1975, included more than 10,000 families from throughout Bolivia.

Table 2

Infant Mortality in Bolivia

Infant mortality (Per 1,000 live births)	Reference
National Average	
154	USAID/Bolivia (1975)
145	PIA/PNAN (1976)
161	CELADE (1976)
250	MPSSP (1970)
Rural	
178	CELADE (1976)
> 300 (some areas)	USAID/Bolivia (1975)
Urban	
59-244 (1972)	USAID/Bolivia (1975)
133	CELADE (1976)
Geographic Region	
Altiplano	
174	CELADE (1976)
Valles	
156	CELADE (1976)
Tropics	
117	CELADE (1976)

The major causes of mortality for all age groups above one year were, in order of importance: 1) Poorly defined (including senility for the > 15 year age group); 2) respiratory diseases; and 3) gastrointestinal diseases. The major cause of death for those under one year was vaguely termed perinatal illnesses, with the second and third causes being the same as the total population (USAID/Bolivia, 1975).

A study conducted by Puffer and Serrano (1973) in several Latin American countries provides more insight into the major cause of mortality in those under 5 years of age (Table 3).

Table 3

Proportion of Mortality in Under 5 Year Olds in Which Malnutrition and Immaturity were Underlying or Associated Causes

Location	Number surveyed	Nutritional deficiency	Immaturity	Total
		Percent	Percent	Percent
La Paz	4,115	36.0	11.5	47.5
Viacha	161	30.4	10.6	41.0

SOURCE: Puffer and Serrano, 1973.

As shown in Table 3, the combined effects of nutritional deficiency and immaturity in two Bolivian cities were associated with over 41.0 percent of all the deaths in this age group. Thus, improvement in nutritional status appears to be one effective means of decreasing the high infant mortality rate.

Immunization programs in Bolivia reach a relatively small portion of the population. According to 1972 data, less than 20 percent of those under 5 years were vaccinated for diptheria, pertussis, and tetanus (DPT). (PAHO/WHO, 1974.)

Water supply services and sewage disposal systems are the exception rather than the rule in Bolivia. According to 1974 data (PASB/WHO, 1974), approximately 23 percent of the population had water supply services, and some 12 percent had sewage disposal systems. A more detailed indication of the available and projected sanitation facilities in urban and rural areas is shown in Table 4.

Table 4

Proportion of Population with Potable Water Supply and Sewage Disposal Services

	Potable Water		Sewage Disposal	
	1975	1980	1975	1980
	Percent			
Urban	56.9	67.0	22.6	37.0
Rural	9.4	17.2	8.4	21.6

SOURCE: PIA/PNAN, 1976.

The expansiveness of Bolivia and the dispersed nature of its population have made advances in sanitation facilities somewhat difficult. Standard public health measures such as vaccination programs, health education, improvements in the potable water and sewage disposal systems, and maternal and child health services would be effective methods of improving the public health status of Bolivians.

Nutritional Indices

One of the conclusions of both the USAID/Bolivia Health Sector Assessment and the Nutrition Sector Assessment was that the Bolivian diet had

deteriorated both in quality and quantity during the past 15 years. The conclusion should be re-evaluated since it was based mainly upon food price indices, trends in agricultural production and qualitative, observational dietary information. In addition, the results of the 1976 census indicate that some of the earlier data from food balance sheets should be re-examined.

Protein-Calorie Malnutrition

Availability and Consumption of Calories and Protein

Food balance sheets and consumption surveys provide an indication of the quantity of calories and protein available and consumed by the population.

Food balance sheets reflect trends in food production and provide useful information for planning agricultural programs. They provide an indication of quantity of food crops produced per capita, but should not be used as an absolute indication of nutritional status.

Prepared jointly by the Ministry of Industry, Commerce, and Tourism (MICT), and the Ministry of Agriculture and Campesino Affairs (MACA), food balance sheets are available for the period 1958-1962, and 1970. Select data for these years and available calories and protein in 1970 based upon growth rates reflected by the 1976 census are shown in Table 5.

Table 5

Information Obtained from Food Balance Sheets

Year	Population estimate	Available/capita/day	
		Calories	Protein (g)
1958-1962	3,650,000	2,108	66.1
1970	4,931,200	1,834	48.7
1970[a/]	4,100,000	2,206	58.6

a/ Compiled from: 1976, unofficial census figures, and rate of population increase (INE, Nov. 11, 1976).

Unfortunately, the 1970 food balance data calculated by using an inflated population estimate has been taken to indicate a deterioration in the Bolivian diet. Based upon the 1976 census, available calories per capita increased by 4.5 percent between 1958-1962 and 1970, whereas total available protein decreased about 11 percent. Until the official data of the 1976 census are applied to food balance data, the information on food availability, per capita, is difficult to interpret.

Consumption data is somewhat limited and, in certain instances, outdated. A summary of consumption data which provide information by geographic region, age, income level, and projections through 1980 is shown in Table 6. The national average consumption of calories per capita/day ranged from 1,870 to 1,998. The latter was based upon a calculated national average from FAO (1972) data. Average intake of total protein ranged from 44 to 57.5 g., whereas the average intake of animal protein was 16 to 18 g./capita/day.

The FAO study clearly illustrated the direct relationship between income and calorie consumption. The largest portion of the population, within the low income level, was consuming a diet very deficient in calories. Although the analogous data for protein were not available, the consumption by income group would be expected to resemble those observed for calories.

The data from the MPSSP (1976) survey indicate that both preschoolers and families living in the Valles consumed more calories and more protein, both total and animal protein than similar groups living on the Altiplano. According to data cited by PIA/PNAN (1976) in which six consumption surveys between 1962 and 1968 were summarized, the calorie and total protein intake (per capita, per day) ranged from 60 to 94 percent and 73 to 116 percent of

Table 6

Summary of Calorie and Protein Consumption
(per capita, per day)

Reference and Subject	Percent of population	Calories	Protein g. Total	Protein g. Animal
Trowbridge and Haverberg (1977)				
1962 data				
Cochabamba		1,971	59.0	
Tarija		1,986	64.0	
National Average		1,870	57.5	
FAO (1972)				
1970 data				
Economic Level				
Low	50	1,356		
Medium	30	2,165		
High	15	2,861		
Very high	5	4,813		
Calculated National Average		1,998		
PIA/PNAN (1976)				
National Average				
1975		1,890	44	18
1980 (projected)		2,000	56	--
MPSSP-PIA/PNAN (1976)				
Region				
Altiplano		1,883		15
Valles and subtropics		1,894		16
Tropics		1,892		24
National Average		1,890		18
Altiplano				
Family		1,739	49.5	5.4
Preschooler		1,006	25.7	3.4
Valleys				
Family		1,954	57.9	12.6
Preschooler		855	21.7	7.3

recommended intake, respectively. It is unclear whether recommended intakes were standard or consistent between studies. Thus, absolute values for consumption were not available and interpretation is limited.

Various nutritional studies in Bolivia have used, or proposed, a range of recommended levels of nutrient intake (Table 7), recognizing the specific needs resulting from a physiological state (pregnancy, lactation), age, or environmental conditions. Even after these factors are accounted for, there are several discrepancies between the various levels recommended. The use of FAO (1974) recommended levels of nutrient intake for various age groups, combined with current population distribution patterns (by age), and consideration of climatic stress for a portion of the population, would result in one standard set of recommendations for nutrient intake. Such a calculation (not including a factor for altitude or temperature) based upon a population distribution assumed to be similar to that of Bolivia, would result in a per capita recommendation for calories of approximately 2,300/day. ICNND (1963) suggested that recommended levels of intake should vary with altitude and region (Table 8).

Upon comparing levels of consumption (Table 6) with various levels of recommended intake (Tables 7 and 8), it appears, in general, that calories are consumed in considerably less than adequate quantities. Protein consumption patterns, however, appear to be deficient mainly in terms of quality reflected by the quantity of animal protein consumed. Protein quality of the diet is improved as the balance of essential amino acids approaches the Provisional Amino Acid Pattern described by FAO (1973). This may be accomplished by either selecting plant proteins with complementary amino acid profiles or animal protein to enhance the balance of essential amino acids.

Appendix B-1

Table 7

Recommended Levels of Nutrient Intake For Various Groups in Bolivia
(per capita, per day)

Reference and Subject	Kcal.	Protein g. Total	Protein g. Animal	Calcium mg.	Iron mg.	Vitamin A mg.	Thiamine mg.	Riboflavin mg.	Niacin mg.	Ascorbic Acid mg.
PIA/PNAN, 1976 (MPSSP)										
Altiplano										
Family	2,208	56.1	16.8	518	10	1,200	0.9	1.3	14.6	48
Preschooler	1,287	27.5	11.0	450	7	700	0.5	0.8	8.5	30
Valles										
Family	2,220	59.0	17.6	497	11	1,199	0.9	1.3	14.6	48
Preschooler	1,349	28.0	11.2	449	8	699	0.5	0.8	8.9	31
Adult 10°C 3,000 m.	2,835	65		450	10	1,300	1.1	1.7	18.7	50
L.K. LOPEZ (1976) (MPSSP)										
Female	2,100	60	18	450	10	1,300	0.8	1.2	13.9	50
Pregnant	2,310	70	21	1,100	14	1,600	0.9	1.4	15.2	65
Lactating	2,940	85	25.5	1,100	14	2,100	1.2	1.8	19.4	95

Table 8

Recommended Intake of Calories and Animal Protein
(per capita, per day)

Region	Calories	Animal Protein g.
Altiplano	2,274	29
Valles and Subtropics	2,248	23
Tropics	2,117	28
National Average	2,213	27

SOURCE: PIA/PNAN, 1976. Based upon accepted values cited in the "Nutrition Survey - Bolivia." ICNND, 1963.

Anthropometric Studies

Protein calorie malnutrition among young children is well recognized as the major nutritional problem in Bolivia. There have been approximately ten studies since 1962 using anthropometric indices to determine the degree of malnutrition in Bolivian children. The studies have been conducted by ICNND, the Nutrition Division within the MPSSP, and volunteer agencies. Summary data of these studies along with some projected estimates (assuming lack of specific nutrition programs) are shown in Table 9. The data cited by PAHO, in which approximately 40 percent of Bolivian preschoolers are malnourished to some degree, make an attempt to reflect a general national average. The 60 to 65 percent total malnourished figures, cited in the USAID/Bolivia Nutrition Sector Assessment seem high when compared with the results cited by MPSSP (1977) and results from the various studies summarized in Table 9. If it can be assumed that the studies reported by the MPSSP in 1972-1974 (Table 9) were designed and conducted in a similar fashion, it appears as though

Table 9

Summary of Studies on the Anthropometric Status of Bolivian Children

Reference and Subjects	Number	Percent total malnourished[a]	Percent malnourished I	II	III
USAID/Bolivia Nutrition Sector Assessment (1976)					
Nationwide average		60-65	40	15-20	5
Projected estimates - 1980		65	45	15	5
- 1985		63	50	10	3
PAHO (1976)					
1966-1969 data	1,968	39.9	29.0	10.2	0.7
Dr. C Abela-Deheza, Div. of Nutrition-MPSSP (1977) (1968-1972 data)					
Altiplano		42.5			
La Paz		52.0			
Valles		48.0			
Tropics		28.0			
USAID/Bolivia Nutrition Sector Assessment (1976) and PIA/PNAN (1976)					
Altiplano					
La Paz - Rural					
1962	479	17.0			
1966	878	42.5	31.0	11.0	0.5
La Paz - Urban					
1972	2,778	42.0	26.0	10.5	5.5
1973	2,308	52.0	30.4	16.3	5.3
Tejar y Alto - La Paz (1962)	702	40.4	28.0	12.0	0.4
Santiago de Llallagua - La Paz (1967)	176	47.0	42.0	4.0	1.0
Valleys					
Cochabamba (1967)[b]	1,338	43.9	32.7	9.6	1.6
Concepcion, Tarija (1968)	154	48.0	41.0	6.0	1.0
Tarabuco, Chuquisaca (1968)	138	39.0	32.0	4.0	3.0
Tropics					
Mineros, Santa Cruz (1973-74)	496	30.7	22.5	7.4	0.8
Santa Cruz (1974)	354	28.0	24.6	2.8	0.6

a/ Total malnourished includes percent classified as I, II and III degree malnutrition.

b/ PIA/PNAN (1976) described this data as cited above; USAID/Bolivia Nutrition Sector Assessment described same data as "3 Rural Areas, La Paz."

malnutrition among preschoolers is more common in the altiplano region (urban La Paz) than in the Tropical Region (Santa Cruz). This trend is similar to that reported by Dr. Abela-Deheza and staff in March 1977, which encompassed several studies from 1968 through 1972 (Table 9).

With the exception of these qualified general observations, interpretation of anthropometric data from the many studies conducted in Bolivia is limited. This is a result of the lack of information available on sampling procedures, methods of gathering data, reference standards, and methods of data analyses used in these studies (Trowbridge and Haverberg, 1977). The use of a standard reference would allow the data to be more accurately compared with that of other countries, as well as with other studies conducted within Bolivia.

Mineral and Vitamin Status

Available information on vitamin and mineral status is often qualitative with few definitive studies reported. Following PCM among 0-6 year olds, iron deficiency anemia among pregnant and lactating women, and goiter are seen as the most common nutritional problems.

Iron deficiency (microcytic) anemia among pregnant and lactating women has been discussed in the USAID/Bolivia Nutrition Sector Assessment. The prevalence and projected estimates of prevalence, assuming no specific nutrition programs would be initiated, are given in Table 10.

Table 10

Prevalence and Predicted Prevalence of Iron Deficiency Anemia Among Pregnant Women

Year	% Anemia
1975	70
1980	68
1985	65

SOURCE: USAID/Bolivia Nutrition Sector Assessment, 1976.

This suggested prevalence of anemia apparently prevails in spite of the reported high intake of iron among Bolivians (PIA/PNAN, 1976). The results of six studies conducted between 1962 and 1967 suggest that from 103 to 234 percent of the recommended levels of iron were being consumed. This apparent discrepancy may be the result of several factors. First, recommended intake for the pregnant woman is significantly higher than that for the average adult population. Second, for those pregnant women living on the Altiplano, additional iron would be required to increase the oxygen-carrying capacity of the red blood cells. Third, the form of iron consumed may not be readily absorbed and, thus, a high incidence of anemia exists in the face of a high consumption of iron.

Iodine deficiency, with the resultant manifestations of goiter and cretinism, has long been a problem in Bolivia. The ICNND (1963) survey indicated that goiter was widespread. Data gathered from several departments in Bolivia are summarized in the USAID/Bolivia Nutrition Sector Assessment (1976). Of 2,953 individuals, less than 15 years of age, 16.4 percent were suffering from some form of goiter. The analogous incidence for those more than 15 was 10.5 percent (CONEPLAN, 1973). Although utilization of salt with KIO_3 was legislated in 1968, less than 1 percent of the population was consuming iodized salt by the early 1970's (PAHO, 1974).

In response to Bolivia's need for iodized salt, the Nutrition Division of the MPSSP reported in February 1977 that UNICEF had installed a dry mix plant for iodization in a salt mine cooperative in Potosi. This mine supplies approximately 90 percent of Bolivia's salt needs. The iodization process was expected to be operative by the summer of 1977.

Calcium needs do not appear to be adequately met by the Bolivian diet. A summary of six studies conducted in the 1960's indicates that the diet provided from 15 to 77 percent of the recommended intake (PIA/PNAN, 1976).

Little has been reported on the vitamin content of the Bolivian diet. That which is available was obtained during the 1960's. Vitamin A intake appears to be low in both the under and over 15-year age groups (PAHO, 1970). PIA/PNAN (1967) summarized earlier studies which indicated that from 6 to 85 percent of recommended intake was being met.

Within the B vitamins, riboflavin intake was reported to vary from approximately 30 to 160 percent of recommended intake in the 1960's (PIA/PNAN, 1976). Most of the data on mineral and vitamin status provides some general indication of variation within the country. Since the available data is at least 10 years old, it would need to be updated before an accurate evaluation of current status could be conducted.

GOVERNMENT NUTRITIONAL POLICY AND PROGRAMS

The well defined infrastructure within the GOB for planning national nutrition strategy and programs, the development by the MPSSP and the Ministry of Planning and Coordination of a Five Year Food and Nutrition Plan, and the close cooperation between USAID/Bolivia and the GOB in the development of USAID Nutrition Stragegy, provide a sound base for the planning phase of nutritional programs within Bolivia. The GOB plan will be initially discussed, followed by the USAID/Bolivia Nutrition Sector Strategy which complements and is supportive of the GOB plan. Finally, some specific examples of on-going food distribution programs will be briefly described.

The Government of Bolivia Program

The GOB, in June of 1976, approved a Five Year Plan (1976 - 1980) which describes nutrition as a sector. The plan, Proyecto Interagencial de Promocion de Politicas Nacionales de Alimentacion y Nutricion - PIA/PNAN -- "La Alimentacion y la Nutricion en el Plan de Desarrollo Economico y Social de Bolivia" -- identifies specific goals and sub-goals.

The three broad goals as cited by USAID/Bolivia are:

1) To meet the demand for basic foods which would allow the attainment of recommended dietary levels;
2) To progressively increase the proportion of local foodstuffs (as opposed to imports) that would meet the national demand for protein and calories; and
3) To decrease the incidence of protein-calorie malnutrition, endemic goiter, nutritional anemias and specific vitamin deficiencies.

Within these goals, some sub-goals or more specific objectives were defined as follows: a) to raise per capita daily consumption of calories from 1890 (1975) to 2200 (1980), and per capita consumption of proteins from 44 to 56g in the same time frame by increasing food availability;[3/] b) to reduce by 20% the total protein and calorie requirements being met by importation of basic foodstuffs (this obviously would require a similar increase in production of these basic foodstuffs or others which could be consumed in their place); c) to reduce by 25% the incidence of PCM in children under 6 years; d) to reduce the incidence of goiter; and e) to reduce the incidence of nutritional anemias and vitamin deficiencies in pregnant and lactating women from an estimated 40% in 1975 to 28% by 1980.

The plan continues by outlining 14 problem areas with objectives and activities to be undertaken.

USAID/Bolivia Nutrition Strategy

The broad goal of the USAID Mission's tenetative strategy in the nutrition sector is "To improve the nutrition status of the rural and marginal urban poor in Bolivia, especially infants and children under six and pregnant and lactating mothers." Objectives to be attained by 1981 are described as follows:

1) To decrease, by 25%, the incidence of degrees II and III PCM in children under 6 years of age within low-income families in both rural and marginal urban areas;
2) To decrease, by 25%, the food gap for infants and children described in (1);

3/ The new census data (INE, 1976) suggest that the 1980 goals may have been reached in 1970 and, thus, consumption may be nearer the 1980 goal in 1975, as well.

3) To decrease by 12%, the incidence of anemias and vitamin deficiencies in pregnant and lactating women, and infants and children under 6 years of age in rural and marginal urban areas; and

4) To decrease, by 12%, the incidence of endemic goiter in the total population.

There are many similarities between these objectives and those defined in the GOB Five Year Plan.

An initial loan of $500,000 has been granted by USAID/Bolivia to assist in the establishment and guidance of a Nutrition Coordinating Group. This group would function within the Ministry of Planning and Coordination. Formally organized in December 1976, this group is charged with coordinating all nutrition plans and activities. Both USAID/Bolivia and the UN, through the Interagency for the Development of Food and Nutrition Policies, have input into this group.

The projected activities of this coordinating group, described as the Food and Nutrition Technical Group (FNTG)[4/] in the USAID/Bolivia Nutrition Sector Assessment, are: a) basic research to gather census and agricultural production data; b) implementation of one aspect of a nutrition program (e.g., nutrition education through mass media) as a training technique for the group; and c) program development studies which could include projects such as quinoa fortification of wheat and/or an evaluation of the effective coverage of the milk distribution program.

This FNTG would be composed of a coordinator (economist, global planning), an agricultural economist, an agronomist, a sociologist, the Director of the

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4/ Other acronyms that have been used are GTAN and GTN.

Nutrition Division, MPSSP, and a food technologist. The role and function of the FNTG within the Ministry of Planning and Coordination is described in the USAID/Bolivia Nutrition Sector Assessment.

The over-all strategy as described by USAID/Bolivia would include an initial 18-24 month period in which the GOB's ability to plan and implement a food and nutrition program would be strengthened. This would then be followed by a three-year loan-grant in which a planned program would be carried out in a limited geographic area. Final long-term plans include implementation of such a program on a national scale.

The efforts of USAID/Bolivia in the Health Sector also have implications on nutritional status and well being. The current Rural Health Loan (USAID/Bolivia) terminates in 1978. Since the program began rather slowly, it was immediately moving into the third phase strategy as of February 1977. This was to include a pilot project of vaccination, beginning in Santa Cruz. Additionally, nutrition education was to be implemented along with sanitation.

The presence of such a health program within Bolivia, even though it may be localized in only a few areas initially, should improve the health status such that the impact of any nutritional intervention would more likely be evident.

Government to Government and Voluntary Agency Programs

Within government to government (Bolivia to U.S.) programs, the Bolivian National Community Development Council works with USAID under a current annual contract with 1,200 MT of commodities per year. These commodities include wheat flour, bulgur, instant corn-soy-milk, soy-fortified rolled oats, soy-fortified corn grits and wheat-soy blend. This program is expected to be phased o

by AID, and CARITAS will assume responsibility. CARITAS also distributes Title II commodities through some 500 Mothers Clubs with USAID serving as a monitor. Within this program, in early 1977, there were some 80,000 recipients. Future plans indicate that the World Food Program will absorb these Mothers Clubs and, subsequently, offer foods for sale at reduced prices. CARITAS is then expected to replace the Mothers Clubs with mother-child health care centers which would be designed to reach the more remote and, hopefully, the "poorest of the poor." This is consistent with current USAID philosophy.

The school feeding program includes approximately 135,000 recipients. It began as a breakfast program, expanded to breakfast and lunch, and is returning to the breakfast program (bread and milk).

The Food for Work Program has 12,000 recipients approved for 1977. Distribution centers will be in La Paz, Cochabamba, and Oruro.

CARE works with its Bolivian counterpart, i.e., The National Social Action Council. They have some 24,000 recipients approved for 1977.

WHEAT AND WHEAT FOODS

Wheat Supply and Prices

Currently about one-fourth of the demand for wheat in Bolivia is supplied by domestic production with the remainder obtained through imports of both wheat grain and flour. In 1975, production of wheat was estimated to be 69,000 metric tons (MT) and imports were estimated at 193,000 MT (wheat and wheat equivalents), for a total apparent consumption in all uses of 262,000 MT.[5/] Prices for wheat and flour are determined administratively. The government sets the price which flour millers must pay for domestically produced wheat. The current price level was established in 1974 at $bs. 190/quintal or U.S. $209/MT.[6/] This is U.S. $9.50 per cwt. Millers in turn are permitted to charge U.S. $15.00 per cwt. for flour in 100-lb. cotton bags. When these prices were established, world wheat prices were in the range of U.S. $200 to $240 per MT. Since that time wheat prices have dropped considerably. In December 1976 Argentine bulk wheat and Argentine flour in 100-lb. cotton bags reportedly could be landed in La Paz for about U.S. $6.20 and $8.71 per cwt., c.i.f., respectively (LeBaron, 1977). Thus, even though millers, by decree, must purchase all locally produced wheat delivered at the mill at the set price, they use various pretexts to either reject offerings of the limited domestic production or to pay a lower price, preferring instead to purchase Argentine flour. This situation reportedly has resulted in the movement of much contraband wheat and flour from Argentina into Bolivia which the government is attempting to stop.

5/ Source: National Wheat Institute and Bolivia Ministry of Agriculture. There are wide discrepancies in wheat production, import and consumption data; e.g., the Economic Research Service, USDA, reported 1975 production of 65,000 MT and imports of 230,000 MT for a total of 285,000 MT.

6/ $bs. = U.S. $0.05

Government Policies and Programs

Much of the authorized imports of wheat into Bolivia, as well as the contraband, is in the form of flour. There seem to be two reasons for this. First, the flour milling capacity is insufficient to mill all of the wheat flour requirements locally. Second, price relationships frequently make it more profitable for the millers, who are currently authorized to do the importing, to import flour rather than mill wheat locally. The government has embarked on a program to require all imports to be in the form of wheat instead of flour.[7/] Millers are expanding milling capacity to adjust to this change. In the near future, the Government of Bolivia (GOB) will eliminate the licensing of wheat imports and become the sole importer of wheat.

Historically, Bolivia has relied on imports to make up for deficits in the requirements for wheat and wheat flour. Until 1974 the cost of wheat and flour imports had never exceeded U.S. $20 million. Furthermore, in many of these years, the availability of PL-480 long-term concessionary financing resulted in a manageable balance of payments situation. In 1974, the worldwide inflation, which especially affected food grain prices, resulted in a Bolivian wheat import bill of over U.S. $41 million. In 1975, food grain prices eased, but the value of wheat and flour imports still remained at about U.S. $30 million (USAID Mission to Bolivia, 1976).

Because wheat is so important in Bolivia's import bill and PL-480 financing is not currently available, thus requiring imports to be financed from foreign exchange reserves or at less attractive credits, the GOB is considering alternate strategies to ease foreign exchange reserve difficulties attributable to wheat imports. One of the strategies that has been actively

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7/ In a report of trip, April 24-26, 1977 to La Paz under the auspices of Great Plains Wheat, Inc., Washington, D.C., Mr. Alvaro de La Fuente reported the planned date for elimination of flour imports as January 1, 1978.

pursued by the GOB, with help from USAID, but with limited success, is to try to increase domestic production of wheat. Other strategies that have been considered but rejected or that have met with limited success for one reason or another include the following: 1) Adopting policies to shift demand from wheat to other products either through price or administrative rationing, or through promotion of consumption of other crops; 2) promoting greater consumption of whole wheat flour, thus increasing the consumption of flour from a given quantity of grain (the extraction rate of flour from wheat in Bolivia is currently reported to be 72 percent); and 3) blending flour produced from other locally grown crops with wheat. The blending of quinoa flour is currently being practiced on a limited scale but it is doubtful whether this could be expanded. Annual quinoa production in Bolivia is about 10,000 MT, and is limited by the long-fallow tradition and competition from other crops, notably potatoes, on the altiplano where this crop is grown.

Wheat production in Bolivia varies widely from year to year. In 1952, largely as a result of the social upheaval accompanying the revolution, wheat production was only 10,500 MT. In 1956, production reportedly reached 82,000 MT but in 1957 fell to less than a third of that amount. In the late 1950's and early 1960's production averaged about 50,000 MT annually, with fairly wide variations from year to year. In 1967, production was less than 30,000 MT but since then there has been a fairly steady upward trend reaching 61,000 MT in 1975.

Most of the annual variation in production prior to 1967 is believed to be due primarily to changes in the area planted. The upward trend in production since then has been due primarily to yield increases which have resulted from the introduction of improved wheat varieties. Even so, yields

are still well below those of many other Latin American countries and other parts of the world. While many observers concede that agroclimatic conditions in Bolivia are not as favorable to wheat production as in the more temperate zones, there seems to be general agreement that utilization of improved technology and farm practices could result in significant productivity increases. Even though such increases would be important they are not expected to result in sufficient production to keep pace with the growing demand for wheat which is increasing by 10,000 to 12,000 MT annually.

Thus, if Bolivia is to grow more wheat and reduce its reliance on imports, additional land must be made available for the crop. A number of factors militate against this possibility. Most of Bolivia's wheat is produced in the southern and central Valles. Technological difficulties appear to preclude any significant production elsewhere. In these traditional areas of production there are large numbers of small, labor intensive farms. Crops are diversified to spread the risk of crop failure and most of the other traditional crops - maize, potatoes, and beans - are well adapted to this area and to the cultural practices followed. These crops also have a comparative economic advantage over wheat; therefore, it is unlikely that wheat output will be increased significantly in these areas.

Wheat production in the Santa Cruz lowlands could be increased by double-cropping it in the winter in rotation with summer crops of cotton, soybeans, or other cereals. This, however, would require large new investments in irrigation facilities, the economic feasibility of which has not been demonstrated (Gomez, D. E., 1976: USAID Mission to Bolivia, 1974 and 1976).

As a practical matter then, Bolivia must continue to rely on imports to satisfy the major part of its wheat needs. In addition to the possibility of conserving on foreign exchange reserves by seeking concessional financing for wheat, it may be possible to effect some foreign exchange savings by substituting flour made from other locally grown crops for part of the wheat flour. The most likely crops for this are rice, corn, and, if nutritional benefits are considered, soybeans. These substitution possibilities will be explored in another section of this report.

Consumption of Wheat and Wheat Foods

Although a large proportion of the calories and protein in the average Bolivian diet comes from the locally produced crops of potatoes, maize, and rice, the largest percentage of both calories and protein supplied by an individual food commodity is from wheat, most of which is imported. In 1970 it was estimated that nearly 27 percent[8/] of the calories and 31 percent[8/] of the protein in the average Bolivian diet came from wheat (USAID Mission to Bolivia, 1974).

Average per capita use of wheat is currently around 110 pounds per year. Most wheat is consumed in the form of commercially made bread which is made from 72 percent extraction flour. Thus, about 80 pounds of wheat flour are consumed per capita per year. In most regions, there is reportedly a decided preference for white flour and white bread.

Reports from a number of sources indicate that wheat consumption, especially in the form of bread, is important throughout the country, in both urban and rural areas and for all ages and income groups. A recent household economic survey reportedly confirms this, although at the time of this visit to Bolivia

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8/ These figures appear high and may have been calculated without considering wheat milling losses.

(February 1977) data from the survey were not available. Data from an earlier study (1972) indicate that there is widespread consumption of wheat foods, especially commercial bread products, throughout the country (Tables 11 and 12). Based on these data, per capita consumption of wheat foods appears to be greatest in the rural areas where most of the nutritionally deficient groups are located. This study also showed that although family expenditures for wheat foods were significant for all income groups, within each area, expenditures were positively correlated with income. Examination of the data for other food categories reveals that there is a positive correlation of family expenditures with income for nearly all foods. This result simply implies that people with higher incomes spend more for all foods than those with low incomes.

No data on consumption of wheat foods by age are reported in the 1972 study. Nevertheless, it was reported to the authors by many Bolivians that bread is eaten by all age groups including infants who are often weaned on bread that has been soaked in coffee to soften it.

Table 11

Estimated Annual Per Capita Consumption of Wheat Foods in Rural Areas by Ecologic Zone, Bolivia 1972

Ecologic zone	Rural population	Annual per capita consumption				
		Wheat	White flour	Whole-wheat flour	Noodles	Bread
	Thousands	Kg.	Kg.	Kg.	Kg.	Each[a/]
Amazon Rain Forest	106	.91	5.52	.83	3.70	75.73
Beni Plain	87	1.93	6.72	1.79	4.23	93.96
Brazilian Shield	92	1.06	6.65	6.06	2.24	63.44
Santa Cruz	92	1.09	16.98	1.39	11.61	209.48
Chaco	176	2.83	28.19	1.88	18.61	113.23
Valles	1,386	12.20	1.95	4.34	4.34	87.70
Yungas	228	4.01	14.32	1.25	10.86	120.18
North Altiplano	328	1.42	1.75	0.07	2.29	68.71
Central Altiplano	954	10.89	5.58	3.04	4.68	101.76
South Altiplano	81	3.84	15.55	7.36	7.97	118.81
All Zones	3,530	8.45	6.07	3.12	5.57	96.21

a/ Weight not designated.

SOURCE: GOB, 1972.

Table 12

Estimated Annual Per Capita Consumption of Wheat Foods in Select Urban Areas by Department, Bolivia, 1972

Department	Annual per capita consumption				
	Wheat	White flour	Whole-wheat flour	Noodles	Bread[b/]
	Kg.	Kg.	Kg.	Kg.	Each
La Paz	4.88	5.54	0.30	8.12	29.94
Chuquisaca	0.59	1.01	--	3.82	47.98
Cochabamba	0.66	2.09	--	4.93	39.51
Potosi	0.35	1.05	--	4.46	49.00
Oruro	0.76	1.16	--	5.95	53.60
Santa Cruz	0.17	0.80	--	3.14	59.76
Tarija	0.47	0.94	--	3.52	49.83
Six-city average[a/]	0.48	1.27	--	4.35	50.05

a/ Average of six major cities (Sucre, Cochabamba, Potosi, Oruro, Santa Cruz and Tarija) within the above Departments excluding La Paz.

b/ Weight not designated.

SOURCE: GOB, 1972.

Status of the Flour Milling Industry

How does one explain the paradox in Bolivia that 73,000 to 95,000 MT of wheat flour is imported while only 75% of the country's 144,000 MT[9/] of wheat milling capacity in its 12 large commercial mills is utilized? The underutilization of the milling capacity has been a continuing problem for some years but the factors causing it have changed. One of the early contributors to this problem was the importation of US flour at concessional terms such that it was not profitable for domestic mills to compete. In following years, a number of interacting factors (and timing) have contributed to generally make flour imports highly profitable while creating a negative incentive for domestic milling: GOB price and marketing supports for domestic wheat; price controls on wheat products; wide swings in international wheat prices; lack of grades and standards; lack of purchasing regulation enforcement; and Argentine subsidy on domestically milled flour. As of February-March 1977, domestic wheat (25% of total supply) was price-fixed at the high level of $9.25/cwt (blando) and $9.50/cwt (duro). These prices were the basis for calculating milling margins and thus the wholesale price of flour which is set by GOB at $15.00/cwt. The price of Argentine flour at the border in December 1976 was $7.18 and laid down in La Paz, $8.71/cwt. At the same time, f.o.b. U.S. Gulf port wheat prices were on the order of $4.00/cwt. At this point in time then, the high profitability of flour imports is clearly evident. The recent history of the wheat marketing situation in Bolivia is more fully discussed by LeBaron (1977).

It appears currently that the milling industry is beginning a period of

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9/ DGNT, MICT estimate as of February 1977.

change/growth, primarily as a result of government plans and actions to eliminate flour imports by January 1, 1978, provide closer regulation of the wheat and wheat food industries and to reduce foreign exchange use for purchase of wheat and wheat flour by substituting domestic crops (quinoa, corn, soy, rice, etc.) for part of the wheat flour. The fact that Argentina is in the process of reducing/eliminating the subsidy on domestically milled flour should be of substantial benefit to the Bolivian program. There appears to be some understanding between the GOB and the milling industry on these matters and the milling industry is increasing its capacity to compensate for planned phase-out of wheat flour imports. Table 13 gives the location and capacity of the 12 large commercial mills in Bolivia and planned expansion for 1977 at three of the mills. Plans for expansion at the other mills were not obtained.

Table 13

Bolivian Wheat Flour Mills and Their Capacities[a]

Mill Location		Name	Capacity, MT of Wheat/day	
			Current	Planned, Dec.1977
La Paz)		SIMCA	75	100
Oruro)	Bedoya	CICO	50	180
Santa Cruz)	family	MODELO	100 (modern)	150
La Paz		Cia Molinera	90	
Cochabamba		Cia Molinera	50	
La Paz		Progresso	20 Internal Needs only	
Oruro		Ferrarigetsi	120	
Cochabamba		San Luis	40	
Cochabamba		IMBA	10	
Sucre		SIDS	10	
Potosi		Rocamador	35	
Tarija		Chapaco	20	
		12	620[b]	

a/ Source: Personnel at SIMCA Milling Co., La Paz.
b/ Equivalent to 161,200 MT/year; 5-day work week.

Sources in the DGNT, MICT (Agency for Standards and Technology, Ministry of Industry, Commerce and Tourism) indicated that it is planned to expand milling capacity to 182,000 MT by the end of 1977.

Pfost and Niernberger (1973) described the Bolivian milling industry as technologically old but serviceable and at the time 80% utilized. There is a Milling Industry Association (ADIM); its headquarters are at 1323 Comacho Avenida, La Paz; Mr. Bedoya, President.

Wheat is also processed on the farm, in the homes and in small businesses. Since only about 10,000 MT[10/] of the domestically produced wheat reaches the 12 large mills, an estimate of this "auto-consumption" can be made by subtracting the 10,000 MT from the domestic production. In 1975, then, the estimate for auto-consumption is 59,000 MT.

Evidently, the types of wheat imported have varied dramatically from low protein French wheats to high protein hard wheats from the United States. Major wheat purchases are completed on about a three month cycle and since there is little blending, the quality of flour produced can change quite abruptly as the source of wheat supply changes. A large percentage of domestic wheat is "blando" (soft) and requires blending to make suitable bread flour.

A 1975 GOB decree requires the addition of 5% quinoa flour to all wheat flour but only one mill, Ferrarigetsi, in Oruro, has so far adopted this practice. The reasons relate to availability of quinoa, lack of processing capability to make quinoa flour, and cost, to include transportation costs to mills at locations other than in the major quinoa growing area around Oruro. The Ferrarigetsi process at Oruro for making quinoa flour was described by personnel at SIMCA. The process was said to involve direct flaming of the quinoa seed followed by

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10/ DGNT, MICT estimate.

peeling/milling. The flaming treatment evidently makes the seed coat and saponin containing sticky matrix below the seed coat dry and brittle thus easier to remove. Patents were said to be involved in the process.

The official wheat flour extraction rate is 72% though the ash content of some flours (0.55-0.60%) suggest they may be on the order of 78 or 80% extraction or that mills or the milling process are not optimized. Also, if the 5% required quinoa flour (ash content approximately 2.5%) is added, this would raise a 0.5% ash flour to 0.6% ash. Personnel at SIMCA Milling Co. gave the products produced at SIMCA as:

72% extraction flour
1-3% segundo flour (0.55% ash)
5% Harinilla (red dog, 1.8% ash; some is sold for dog food)
20% bran
0.5% germ (Santa Cruz plant only: MODELO)

In Bolivia, the avoirdupois pound (453.6 grams) is used as the measure of flour but the Spanish pound (460 grams) is used for millfeeds. SIMCA uses an ozone bleach (maturing agent) on their flour and will add other oxidants (European source, not bromate) if necessary to improve quality. There is no enrichment. All flour is bagged in 100 lb. capacity cotton sacks.

GOB specifications for wheat flour were developed by a joint committee of the DGNT, MICT; ADIM (Millers' Association); and the Bakers Union:

Requirement	Minimum %	Maximum %
Moisture	-	14
Protein (Nx5.7)	10	-
Ash	-	0.6
Fat Acidity expressed as H_2SO_4	-	0.13
Crude Fiber	-	0.3
Gluten: wet	28	-
dry	9	-

The DGNT is building up its cereals laboratory in order to improve its ability to monitor and regulate the quality of wheat flour and other cereal products. Additionally, the facilities will provide a GOB capability for R&D on composite flours. Equipment on hand includes modern balances, muffle oven, vacuum oven, spectrophotometer, centrifuge, microscopes, microbiological equipment, including an incubating oven, and a central chemical/glassware storeroom. Test baking is carried out and capabilities will be enhanced when the ordered Farinograph, Extensograph, Amylograph and Brabender Jr. flour mill arrive.

The DGNT is considering and exploring a number of possible innovations in the wheat foods and cereals area. For example, the Department of Technology of the DGNT has prepared (November 1976) a project outline on composite flours. In discussions with members of the DGNT, interest was indicated in the possibility of making available flours of different extraction rates, e.g., 75, 80 and 83%.

Status of the Baking Industry

The baking industry of Bolivia can best be described as one of small-scale artisans. The MICT licenses bakers under a handicraft category. Handmade bread is estimated at 90% of the total. There is a Baker's Association (more a union) with headquarters on Sagarnaga Street in La Paz.

The basic bread process involves the following: combine yeast and water, add sugar, flour and salt, hand work to a dough, ferment 2 hours near the oven, form dough pieces, variable proof, and finally bake. The common bread piece is 60 grams and the GOB fixed price is $bs. 0.5 (U.S. 2.5¢). The typical bread formula is:

Ingredient	Quantity in Kg.
Bread Flour	46.0
Compressed Yeast	0.5
Sugar	1.0
Salt	0.7
Water	28.0

Standard Brands of La Paz has both compressed yeast and dry yeast. In Santa Cruz, only dry yeast was said to be available.

Industria Unidas El Progresso, La Paz, is an integrated miller, baker and pasta manufacturer. The company uses 7.5 MT of flour each day for bread production. A small quantity of crackers and biscuits (150 Kg/day) are also produced.

Status of the Pasta Industry

Industria Unidas El Progresso, La Paz, produces 5 MT/day of pasta with capacity to produce 7.5 MT/day more. SIMCA and Ferrarigetsi Milling companies also produce pastas. The total number of pasta manufacturers was not determined.

Evidently, the pasta industry is quite competitive as indicated by the under-utilization of capacity at Progresso.

At Progresso, both long goods and short goods are produced using modern equipment from Brazil, Argentina and Europe. All products are made using 100% wheat flour but no durum. No enrichment is used. Yellow food color imported from the U.S. is used in some products.

COMPOSITE FLOURS

Composite Flour Experience in Bolivia

The concepts of protein fortified wheat flour and other composite flours are not new in Bolivia. Contec, a private consulting firm in Santa Cruz was hired in 1975 by the Commite Obras Publica de Santa Cruz (Regional Development Corporation in the public sector) to evaluate the feasibility of such products for the Santa Cruz Department and for Bolivia. Contec in turn brought in composite flour experts from Colombia. Contec concluded that a number of products were technically feasible. These included a 12% rice-6% soy- 82% wheat flour pasta; pasta extended with precooked corn flour; and 6 and 12% soy fortified breads. Contec has submitted a report and proposal for further development of composite flours to the Commite. Mr. Tomas Tirado Kruger of Contec suggested that composite flour pastas will be adopted because they are economical.

Mr. Pedro Bleyer, Nutrinal-Maisoy Companies, Santa Cruz, has supplied 1 MT of a 15% soy-85% corn extrusion cooked product to a local Santa Cruz pasta manufacturer for evaluation in pastas.

The GOB's decreed use of 5% quinoa in wheat flour is another example of the country's experience with composite flours. Ing. H. Gandarillas, MACA, has studied 10, 20 and 30% additions of sweet quinoa flour in bread. Addition of 10% quinoa was not detectable and the bread had improved keeping quality.

Composite flours apparently also are produced in Bolivian homes. It has been said that families in the valles have often made wheat-corn composite flour for home bread production.

However, successful experimentation and local or regional food habits do not necessarily mean that they can be transferred across the board to a broad national program. In particular, the adequacy of domestic crops under consideration and their appropriate processing, transportation, and blending into the wheat flour will need to be evaluated carefully. Other critical aspects to be considered are the adaptability of the composite flour to the manufacture of all the traditional wheat foods, acceptability and compatibility with GOB political, economic, nutritional and agricultural policies.

Le Baron (1977) has analyzed the economics of using rice and soy in a composite flour program in Bolivia and concluded that the benefit/cost ratio was on the order of 0.7 - 0.8 for substituting 6 to 25% of either soy or rice for imported flour. These negative indications, however, do not place a value on any nutritional benefits that might be gained, of the value of providing a market for an otherwise wasted or downgraded commodity, of the value of foreign exchange savings, or of stimulating domestic agricultural production and incomes. The basic price considerations in the calculations were 13.2¢/lb. for rice flour produced at the wheat flour mill in La Paz, 11.3¢/lb. for food grade defatted soy flour delivered at the flour mill, and 8.7¢/lb. for imported wheat flour delivered at the mill. These prices include normal profit margins to the indicated point in the marketing system. The potential for rice, corn and soy as wheat extenders is discussed further later in this document.

Protein Fortificants

Oilseed crops in Bolivia include cottonseed, peanuts, and some soybeans. There is also minor production and/or experimentation with sunflower and sesame. All of these oilseeds are theoretically sources of protein for fortification of wheat foods. Because of the time constraints for fulfilling the requirements of the WRRC/AID wheat fortification contract (April 1979), the lack of availability of a significant domestic supply of most of these oilseeds in the near future, and the limited amount of developmental work that has been done on some of these oilseeds for producing protein for human consumption, only soybeans will be given consideration in this report.

The demand for fats and oils continues to increase in Bolivia with the estimated demand for vegetable oils in 1977 rising to over 10.5 million liters (MACA, unpublished). The government is committed to a policy of becoming self-sufficient in vegetable oils and producing an exportable surplus initially through reliance on imports of part of the oilseed requirements, and eventually through local production of all oilseed needs. The five-year agriculture plan, 1976-80, calls for encouragement of local production of oilseeds, including soybeans, through research, extension, and farm credit programs.

Soybeans

According to government reports, there are many areas within the country with appropriate ecologic conditions to support a large soybean production. Soybean production did not begin seriously until 1969-70. Since that time, soybeans reportedly have not been as profitable as cotton, particularly as a small-farm crop and, therefore, production has been limited. With the help of government supported research and credit programs and programs to bring large new tracts of land under irrigation in the area of Villamontes near the

Argentine border, production of soybeans, along with other oilseeds, is expected to increase. Problems with getting an adequate supply of the required hand labor for cotton production in these areas - most of which must come from the Altiplano - also will tend to favor production of soybeans which can be planted and harvested mechanically.

Bolivia already has the oilseed processing capacity to produce several times the domestic requirements for vegetable oils. There are two large modern solvent extraction plants on stream, plus five smaller plants, all but one of which are expeller plants. One of the large modern plants (FACSA), located in Villamontes, is owned and operated by a government agency (Corporacion Boliviana de Fomento). This plant has a processing capacity of 300 MT of oilseeds per day. It would require modification and some new equipment in order to have a food-grade soy flour capability. The other large modern plant, located in Santa Cruz, is a private corporation (Sociedad Aceitera del Oriente). It has a processing capacity of 200 MT per day and with some process modification and additional equipment could produce defatted soy flour for human consumption.

In the past year, the capacity of both of these plants has been grossly underutilized because of an inadequate supply of oilseeds from either domestic or imported sources. If the government's agricultural plans materialize, these two plants, along with the other smaller plants will have a sufficient supply of oilseeds to operate at capacity. At present, it is uncertain what part of this production will be from soybeans. However, in order to process the quantity of defatted soybean flour needed to fortify all of the wheat flour presently produced in Bolivia, a relatively small part of the capacity of one of these plants would suffice.

Two estimates of the quantity of defatted soy flour required to fortify all of the wheat flour produced in Bolivia, made by persons in the soybean processing industry, were 10,000 and 15,000 MT annually. This would be equivalent to 17,900 and 26,850 MT of soybeans, respectively, or 60 and 90 days of operation per year on soybeans alone in the CBF plant.[11/]

Even though 69,000 MT of wheat were produced domestically in 1975 and the equivalent of another 193,000 MT of wheat were imported, about half in the form of flour, only about 110,000 MT of wheat were milled in commercial mills. At a flour extraction rate of about 72 percent, this amount of wheat would result in about 80,000 MT of flour. If a 6 percent substitution of soy flour for wheat flour were to be made in only this part of the wheat flour supply, it would require a minimum of about 5,000 MT of defatted soy flour. If the government's program for importing all wheat requirements in the form of wheat were successful, and wheat flour were fortified with 12% soy flour, a maximum of 20,000 MT of defatted soy flour would be required to fortify all wheat flour consumed in Bolivia. The planned yearly capacity for food grade defatted soy at the FACSA plant of the CBF at Villamontes is 20,000 MT.

Two factors which will determine how much, if any, soy flour will be used for fortification of wheat flour in Bolivia are consumer acceptance and costs in relationship to nutritional improvement. Consumer acceptance can be determined only through consumer testing. With regard to costs, the Ministry of Agriculture and Compesino Affairs, in cooperation with the Consortium for International Development (CID), has undertaken studies of the economics of substituting various locally produced commodities in wheat flour. A study on soy flour substitution (LeBaron, Feb. 1977) has already been completed. This study estimated that soy flour would cost U.S. $11.25 per 100 pounds compared with $8.71 for Argentine flour landed in La Paz.

11/ One ton of defatted soy flour requires 1.79 tons of whole soybeans. U.S.D.A., Econ. Res. Serv. June 1965.

At the time of the CID study, soybean meal was reported to be selling at U.S. $125 per MT f.o.b. Santa Cruz or $5.68 per 100 lbs. The difference between the price of soy meal and the estimated price of soy flour in the CID study is accounted for by the additional processing costs, the reduced value of that part of the soy meal that is a byproduct of the process, and the freight costs from the factory in Santa Cruz to La Paz. Since the price of soy meal is not fixed in Bolivia, it would be assumed to fluctuate with world market prices. However, there reportedly is little local demand for oilseed meals in Bolivia because cattle are mostly grass fed. If this situation continues, as oil extraction expands in Bolivia, meal prices would tend to fall. This situation plus fluctuating world market prices for wheat would result in situations when the price for soy flour could be lower than wheat flour. In addition, the marginal costs allocated to the production of soy flour in a factory built primarily for oil extraction is a policy decision based on a number of considerations and, therefore, could be lower than the estimate in the CID report. These factors require further evaluation before it can be determined that soy flour will always cost more than wheat flour in Bolivia.

Wheat Bran

In a country which reportedly extracts only 72 percent flour from wheat, the remaining low cost bran fraction theoretically provides an economically viable source of Concentrated Wheat Protein (CWP)[12/] which can be used for wheat food fortification as well as other uses. Since high extraction flour has already been tried in Bolivia and reportedly found to be unacceptable to consumers, some government officials believe that CWP should not be considered for use in a flour fortification program in Bolivia. However, the Department

12/ Also called Wheat Protein Concentrate (WPC).

of Standards in the Ministry of Industry, Commerce and Tourism is studying a proposal to adopt standards for flour of two or three different levels of extraction which would utilize part of the available low-cost bran fraction and give consumers a wider choice in the types of wheat flour available.

Carbohydrate Sources

Although in past years Bolivia has experienced some foreign trade deficits, because of recent discoveries of petroleum and gas deposits and large export earnings from tin, the country's future balance of payments situation appears favorable. Nevertheless, the policy of the government is to encourage the production of food crops for both domestic consumption and for export. Since wheat is the largest food import and since the growth in domestic production of wheat seems to have plateaued, consideration could be given to the use of low cost indigenous carbohydrate crops in blends with commercial wheat flour. This could be done either independently or in conjunction with soy flour to reduce overall fortification costs.

Several crops are grown in Bolivia which could be used for blending with wheat flour. Theoretically, rice, corn, sorghum, potatoes, yuca, quinoa, and several other minor crops could be used for this purpose. Many of these would require considerable development work before their use would be technically feasible and the production of some would have to be increased substantially before an adequate supply could be made available above that now being consumed directly. Again, because of the time constraints for the

implementation of a wheat fortification program specified in the WRRC/AID contract, only rice and corn will be evaluated as possible blending agents. Major criteria that need to be considered in evaluating these commodities are consumer acceptance of the final product, availability of supplies, nutritional effects and relative prices. Some of these factors are discussed below.

Rice

Bolivia has been pursuing a policy of expanding acreage and production of rice, especially in the lowland areas. Annual production has increased steadily and Bolivia has not only achieved self-sufficiency in rice production but now has exportable surpluses.

Average annual production of rice (rough basis) increased from 61,330 MT during 1963-65 to 73,301 MT in the 1972-74 period. According to projections in the Ministry of Agriculture's 5-year plan for 1976-80, production will increase from 87,496 MT in 1976 to 110,698 MT in 1980.

The balance between projected supplies and demand for rice for 1976-80 are all on the plus side. In 1976 the difference between projected supply and demand ranges from 27,449 to 28,489 MT. By 1980 this difference between supply and demand is projected to range from 38,068 to 41,518 MT depending upon the level of internal demand. There are now 39 rice mills in Bolivia all operating at capacity. The construction of additional mills is planned as production expands.

The difference between supply and demand for rice is expected to be an exportable "surplus." Part of it could be used to decrease wheat imports by producing rice flour to blend with wheat flour. Whether or not it is feasible to use rice for this purpose will depend upon comparative prices for wheat and rice flour.

The CID study, referred to previously, (LeBaron, Feb. 1977), estimated that the cost of rice flour in La Paz would be U.S. $13.21 per 100 pounds, based on the government price for broken rice which, at the time of the study, was reported to be about U.S. $11.00 per 100 pounds delivered to La Paz. At this price, the use of rice flour for blending with wheat flour would not be feasible. The advantages of rice for this purpose, however, are that its production and marketing are strongly supported by the government and its production is expected to increase beyond domestic needs for direct consumption. Furthermore, during the time of the assessment of Bolivia, one food processor in Santa Cruz reported that he recently had been offered broken rice for U.S. $6.00 per 100 pounds. Freight costs from Santa Cruz to La Paz, according to the CID study, were U.S. $1.27 per 100 pounds, thus, the total price of this rice in La Paz would have been U.S. $7.27 per 100 pounds. This compares to U.S. $8.71 per 100 pounds for Argentine flour delivered to La Paz at the time of the CID study. For these reasons, the use of rice for blending with wheat flour should be further evaluated with added consideration being given to the effects this use would have on nutrition and on internal employment and foreign exchange savings.

Corn

More land is devoted to corn in Bolivia than to any other cultivated crop. Most corn is grown on small farms in a diversity of varieties over a wide area from Lake Titicaca to Santa Cruz. Yields are low but production is generally sufficient to satisfy domestic demand. About half of all corn produced is used on the farms on which it is produced and the other half enters commercial channels. Similarly, about half of the production is used for human

consumption and the remainder is fed to livestock. The demand for corn is increasing due to greater interest in its use as a livestock feed (Foreign Agricultural Service, 1974).

In 1975 corn production was reported to be 330,000 MT and opportunities exist for increasing production by expanding the area under cultivation and through adoption of new yield increasing technologies. The 5-year agricultural plan (1976-80) calls for increased production through continuation of work to select and introduce better yielding varieties and to strengthen programs to disseminate improved technological information to corn farmers.

Corn may be the most economically attractive commodity for wheat substitution. Reportedly, in some of the rural areas where corn is grown, ground corn is regularly mixed with wheat flour for making bread. The price of corn is not regulated by the government and a direct comparison of prices indicates that substitution of corn for wheat could result in cost savings. Two sources reported that the price of corn seldom goes over U.S. $6.00 per 100 pounds (personal interviews). This compares with U.S. $6.20 for Argentine wheat delivered to La Paz, the price used in the CID study. Another source reported that in 1974 corn prices in Cochabamba ranged from U.S. $7.00 to $8.00 per 100 pounds compared with $10.55 for Argentine wheat at the Bolivian border (Foreign Agricultural Service, 1974). If domestic corn is substituted for imported wheat it also could result in foreign exchange savings and increased employment and income opportunities in the agricultural sector of Bolivia.

For commercial use in composite flours, corn must be processed and part of the grain must be removed for other uses. In the United States today, corn is completely dehulled and degermed to yield corn endosperm flour of bland flavor and improved stability. Corn oil is recovered from the germ and the

residual plus the hull is used for animal feeding. The yield of corn endosperm is about 60 percent. The price for corn millfeed is generally similar or only slightly less than for whole corn, whereas oil is generally higher in price.

Current corn flour processing capacity in Bolivia is limited. In addition, the general marketing structure for corn and corn products is rudimentary (Pfost and Niernberger, 1973) and would require substantial modification for a large-scale corn-wheat flour blending program. This does not mean, however, that existing corn flour processing capacity could not be used to initiate a pilot-scale program. For a larger scale program, new corn processing facilities would have to be constructed and the marketing structure for corn modernized.

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CASE FOR A WHEAT FLOUR FORTIFICATION PROGRAM IN BOLIVIA

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CASE FOR A WHEAT FLOUR FORTIFICATION PROGRAM IN BOLIVIA

Population and Economic Status

Bolivia is a landlocked country of 4.6 million people (1976 Census) with the population growing at an annual rate of about 2.7 percent.

There are four major regions in the country which are divided into a total of ten ecologic zones. The four regions are the altiplano with north, central, and southern zones; the valles which is a single zone; the yungas, another zone; and the oriente which is divided into five zones.

About 42 percent of Bolivia's population reside in the north and central altiplano on about 9.2 percent of the land area. Another 35 percent of the people reside in the valles on about 13.1 percent of the land area. The remaining 23 percent of the population is widely scattered over 77.7 percent of the land and would be difficult and costly to reach in any kind of nutrition improvment program.

The rural population is 70 percent of the total. Over three-quarters of these live in the most densely populated altiplano and valles regions.

Average per capita GNP in Bolivia is equal to U.S. $203 and growing at 3.5 percent per year (1973).

The general cost of living in Bolivia has been rising steadily over the past several years and food prices especially, have increased sharply.

Since 1950, Bolivia has faced a chronic balance of payments problem. In recent years, the situation has been more favorable as a result of increased petroleum and mineral prices and recent new discoveries of petroleum. Historically, agricultural imports - especially food - have contributed significantly to the import bill, with wheat and flour representing the largest share.

Agriculture

Although agriculture is the main source of employment, a major source of domestic income, and a large export earner, there is considerable underemployment in the agriculture sector, especially among the small farmers of the altiplano and valles. This has resulted in an outmigration from these areas to urban areas where these rural migrants generally join the ranks of the unemployed. Because of the limited capacity of the urban areas to absorb these migrants, the government is attempting to expand agricultural employment opportunities and to encourage migration to areas which have the greatest potential for agricultural development but which are now the least populated. Increasing production and use of local crops that could be substituted for part of the large imports of wheat would assist in this effort. For several years, the GOB and USAID cooperated in a project to attempt to increase wheat production, but generally this effort has met with little success. Attempts are also being made to increase production of other grains and soybeans and there have been some successes.

In 1976, the GOB published a five-year Agricultural Plan, some of the objectives of which are to assist in increasing internal production of agricultural commodities, especially by small farmers; to increase self-sufficiency of the food supply; to move toward equal development of all regions; and to reduce underemployment and make better use of natural resources.

Nutrition

On the basis of gross food balance data, Bolivia appears to be meeting its effective demand for food. However, infant mortality is estimated by some sources to be as high as 250/1,000 live births. Nutrition and public health problems seem to be the result of inadequate incomes, cultural beliefs and practices regarding food, lack of effective food distribution channels in some areas, poor sanitation, and a lack of effective public health measures.

Information from the GOB Department of Nutrition indicates that the most seriously deficient groups with regard to PCM, in order of importance, are first, children up to 5 years old; second, pregnant women and nursing mothers; and third, school children. Geographically, the most nutritionally vulnerable groups are the rural population and the urban poor. Based on 1968-72 data 52 percent of the children up to 5 years old, in La Paz, suffer from grades I, II, III PCM. For the other parts of the altiplano, this percentage is 42, for the valles it is 48, and for the lowlands 28 percent. There is some disagreement as to whether protein or calories are most limiting.

The areas with the most highly concentrated populations are where the most serious PCM problems are and, therefore, would be the easiest to reach with a wheat fortification program.

Information on vitamin and mineral adequacy is scanty. Iodine deficiency has been determined but is expected to be corrected by the recent installation by UNICEF of a salt iodization plant at a cooperative salt mine in Potosi which supplies 90 percent of all salt in Bolivia.

In 1976, the GOB published a five-year National Food and Nutrition Plan. The general goals of the plan indicate a commitment to meet the basic food needs of the people, to increase production of local foodstuffs, and to decrease the incidence of nutritional deficiencies such as PCM. A specific goal is to reduce by 20 percent the total protein and energy requirements currently met by imported foods.

There are currently some nutrition improvement programs in operation which reach a limited number of those in need. Some of these are nutrition education programs, some are donated foods programs, and some sell food at subsidized prices or provide food for work. Most of these attempt to reach the poorest of the poor but their effectiveness is questionable because of poor planning, lack of coordination and under funding.

A nutrition Coordinating Group was formally organized in December 1976 in the Ministry of Planning and Coordination. An initial loan of $500,000 has been provided by USAID to assist in the establishment and guidance of this group which is charged with coordinating all nutrition plans and activities. Both USAID and the UN will have some input in advising this group through the Interagency for the Development of Food and Nutrition Policies. The projected activities are the gathering of census and agricultural data relating to nutrition; implementation of one aspect of a nutrition improvement program as a training measure (e.g., nutrition education via mass media); and program development studies (e.g., evaluation of a planned program of milk distribution).

This group's support would be essential for getting government approval to implement a wheat fortification program in Bolivia.

Consumption of Wheat Foods

Reports from a number of sources indicate that wheat consumption, especially in the form of bread, is important throughout the country and for all income groups. A recent Household Economic Survey apparently confirms this, although at the time of our visit data from this survey were not available. Data from an earlier (1972) study indicate that although there is widespread consumption of wheat foods throughout the country, the consumption of all wheat products is positively correlated with income. In the same study, it was found that in rural areas more of the households purchased rice in a given time period than either flour, bread, or noodles, but quantities were not specified. Other data from the study indicate that commercially produced bread is the most popular form of wheat food. Reportedly, infants are most often weaned on bread soaked in coffee to soften it.

Average per capita use of wheat is around 110 pounds per year, mostly in the form of commercially made bread. Most bread is made from 72 percent extraction flour and in most regions there is reportedly a preference for white bread.

Wheat Food Industries

Although about 60,000 M.T. of wheat are produced each year, only about 10,000 M.T. enter into commercial milling channels. Because of the large per capita consumption of wheat foods, the equivalent of 200,000-plus M.T. of wheat is imported annually. About half of this is imported in the form of wheat and the other half in the form of flour.

The commercial wheat milling industry consists of 12 mills widely scattered throughout the country, especially in the most densely populated areas. These mills have milling capacities ranging from 10 to 120 M.T. of wheat per day, with a total annual milling capacity of 144,000 M.T. Only about 75 percent of the milling capacity is utilized because, although the government controls imports by issuing import licenses to millers, it is usually more profitable to import flour than wheat; therefore, much contraband flour comes into Bolivia from Argentina. The GOB is attempting to reduce, and eventually eliminate, flour imports by more control and surveillance, and by encouraging the milling industry to increase the capacity of existing mills.

Flour from the mills is sold to Tienda operators who in turn sell to bakers, noodle makers or to the retail trade for household use.

The baking industry of Bolivia can best be described as one of small-scale artisans. The Ministry of Industry licenses bakers under a handicraft category. Handmade bread is estimated to be 90 percent of the total. The common bread piece is 60 grams and the fixed price is bs. $.60 (about U.S. 3.0 cents). Because price is the major determinant in purchasing imported wheat, and little or no blending is done, there is a wide variation in the quality of flour (protein content may vary from 9 to 14 percent). Under these conditions, bakers presumably are accustomed to a wide range of performance characteristics for bread doughs and, therefore, could probably adjust to any

baking performance effects that may result by addition of fortificants or extenders to wheat flour.

Potential for Locally Available Fortificants and Extenders

Bolivia is already engaged in, or studying the feasibility of extending wheat flour with locally produced crops. Legislation has been passed requiring the addition of 5 percent quinoa flour to wheat flour. This law is not enforced, however, because there is inadequate production of quinoa or of quinoa flour to accomplish it in more than a small part of the flour. In addition, the free market price of quinoa in Peru is higher than the fixed price in Bolivia, therefore, large quantities of quinoa are illegally exported to Peru. Because quinoa is grown by small farmers on the altiplano and it is government policy to assist in the equal development of all regions of the country, there is considerable interest by some government officials in production and processing research and programs that would stimulate quinoa production and use.

The Ministry of Agriculture has been charged by the Ministry of Planning to study other possibilities for wheat substitution. The Ministry of Agriculture, in cooperation with the Consortium for International Development (C.I.D.), has undertaken studies of the economics of substituting various locally produced commodities in wheat flour. Already completed are studies on soy and rice. Studies on maize, yuca, potatoes, and other less important crops are being planned.

Of greatest interest to our program is the potential for soybean production and processing in Bolivia. There are two large modern solvent extraction oilseed processing plants in Bolivia. One reportedly has the capability of producing food grade defatted soy flour and the other could make food grade soy flour by installing additional equipment. Both plants have been operating at far less than capacity and largely on imported oilseeds.

A local supply of soybeans for one of the plants (C.B.F.) near the Argentine border awaits the development of an irrigation system for producing the crop. In the meantime, plans are to operate on soybeans imported from Argentina. The other plant (S.A.O.), located in the Santa Cruz area, claims that there are 90,000 acres of unused land in the Santa Cruz area suitable for soybeans as well as other crops, but the land remains unplanted because of inadequate availability of financing to farmers.

Although there will be some soybeans processed in both of these plants, either locally produced or imported, they reportedly will never operate at capacity on locally produced soybeans. The reason is that the return to the farmer for other crops that can be grown on the same land, especially cotton, is greater than for soybeans.

With regard to the price of soy flour, as compared to wheat flour, the study by the C.I.D. showed that soy flour would cost U.S. $11.25 per 100 lbs. compared with U.S. $8.69 for Argentine flour delivered to La Paz. This study is based on static prices and a number of assumptions which may or may not be valid. In February 1977, for example, the price of Argentine flour in La Paz was about U.S. $11.00 per 100 lbs., but no price quotations were available for soy flour.

Some locally grown commodities could be used as wheat flour extenders, in conjunction with soy flour, to possibly reduce the total price of the composite flour. Most of these crops would require considerable development work and/or production increases before their use would be feasible. Two possible exceptions to this are rice and corn. Because of the time constraints of our project, only these two will be given consideration.

The production of both rice and corn can be increased to meet the demand and government programs are aimed at increasing production of these crops. The C.I.D. study estimated that the cost of rice flour in La Paz

would be U.S. $13.21 cwt. based on the government price for broken rice. At this price, it would not seem that use of rice flour would be feasible as a wheat flour extender. The advantage of rice as a possible flour extender, however, is that its production and marketing are strongly backed by the government and its production is very stable; therefore, its supply would be reliable for a fixed formulation composite flour. Its use for this purpose, therefore, should be further evaluated with consideration being given to its effects on internal employment and foreign exchange savings, as well as its cost.

Corn may be the most economically attractive commodity for wheat substitution and, reportedly, in some of the rural areas of Bolivia where it is grown, corn flour is regularly mixed with wheat flour for making bread. The maximum price for corn in Bolivia is seldom over U.S. $6.00 per cwt. This compares with $7.20 for wheat at the Argentine border and about $11.00 for rice which were the prices used in the C.I.D. study. If processing costs for corn were not more than for wheat, it could be used in a composite flour program, along with soy, to reduce overall costs.

Another locally available protein source that should be mentioned is wheat bran. Since 72 percent of the wheat is extracted for flour, the remaining low cost bran fraction provides an economically viable source of concentrated wheat protein. The only question with regard to the use of CWP is consumer acceptance. Since high extraction flour has already been tried and found to be generally not acceptable, some Bolivian officials believe that CWP cannot be considered in a flour fortification program in Bolivia. This is not to say that CWP could not be extracted for specialized end uses.

In-Country Capability and Interest in Carrying Out A Wheat Fortification Program

Capability and interest imply technical, financial, and political considerations. Since the GOB is already pursuing policies and programs for increasing the production of crops that could be substituted for imported wheat, and studies are underway on composite flours, it would seem that any possible political considerations to such programs have already been dealt with.

The Norms and Technology Agency of the Ministry of Industry and Commerce is carrying out a number of programs and is planning others to improve the wheat foods industry. One important program is the establishment of a quality control program on flour. Stability of flour quality would undoubtedly ease the production problems of bakers and thus enhance the success of a flour fortification program. This agency also has prepared a five-year plan on composite flour development. It has already acquired and trained technicians in baking and composite flours and has been equipping a cereals and baking laboratory to carry out product development, testing, and technical control. This agency would be an appropriate counterpart through which to provide the necessary technical assistance for a flour fortification and extension program.

With regard to financial considerations, it would seem that if a flour fortification program resulted in a higher direct cost that the willingness of the government to pay for the higher cost would depend upon the beliefs of policy makers concerning its cost effectiveness. Since the country has embarked on a program of nutrition improvement, the primary consideration would seem to be whether the possible added cost of flour fortification was the most cost effective way of achieving the desired results. There is no way of second guessing what that decision would be without presenting a proposed plan of action for protein fortification of wheat flour to government policy makers for their consideration. Such a proposal follows:

Proposed Plan for Developing a Wheat Flour Fortification Program in Bolivia

Implementation of the following three-phased plan will depend upon overall approval by appropriate Bolivian officials who must also review the results at the end of phase I and II and approve initiation of the subsequent phases. It is proposed that an intergovernmental/private sector committee be appointed to review the plan, suggest modifications, and present it to the appropriate officials for approval. It is suggested that the committee consist of representatives at a policy-making level from at least the following: The Ministries of Planning, Agriculture, Health, and Industry, Commerce, and Tourism; the Millers Association (ADIM); the Bakers Association (Industria Nacional Panificadora); and a representative of the soybean processing industry (perhaps C.B.F.).

The three-phased plan will take place over a two-year period.

PHASE I. Work with, provide technical assistance to, and provide minor financial assistance for purchase of necessary supplies to the Department of Technology in the Ministry of Industry, Commerce and Tourism, to carry out laboratory testing of soy fortification of the flour used for production of the common bread consumed in Bolivia. The following elements will be included:

a. Collection of flour samples from several Bolivian flour mills.

b. Acquisition of a supply of soy flour from the C.B.F. oilseed processing plant at Villamontes. If not available, U.S. soy flour will be purchased and used.

c. Test baking and evaluation of flour samples with and without dough conditioners using different levels of soy flour. If officials believe it necessary to use an extender to reduce overall formulation costs, rice and/or corn flour also will be acquired and used in the tests. This

decision may require further evaluation of costs of these flours. If so, the WRRC/AID economist will assist the Ministry of Agriculture and C.I.D. in making these estimates.

d. Conduct organoleptic evaluations of test runs of soy fortified bread.

e. Select a formulation for more extensive testing and consumer acceptance studies.

PHASE II. Work with, provide technical assistance to, and provide minor financial assistance for purchase of necessary supplies and equipment to the Department of Technology, a miller, and two bakers to produce, under commercial conditions, a small supply of soy fortified flour and bread made from this flour for evaluation and consumer testing. If a decision to use rice or corn flour was made in phase I, this also will be acquired and used in the formulations. The following elements will be included:

a. Obtain agreement with a miller to produce a supply of fortified flour. The mill at Oruro already produces a composite flour using quinoa flour and presumably has mixing equipment in place so will be approached first for this purpose.

b. Obtain agreement from a baker in Oruro and one in Santa Cruz to conduct test runs on the fortified flour.

c. Contract with a university or a local market research firm to carry out consumer acceptance tests on the test runs.

d. When elements a, b, and c are accomplished, acquire the necessary ingredients and work with the Department of Technology, the miller, the bakers, and the consumer testing group to achieve objectives implied in these elements.

e. Prepare a report of results for presentation to the inter-governmental/private sector committee for evaluation. If results are positive,

concurrently propose to the government, through the committee, that they require all flour milled in Bolivia to be fortified with soy flour (level to be determined in phase I) and, if deemed necessary in phase I, extended with appropriate amounts of rice and/or corn flour.

A range of quantities of each ingredient in the formulation should be specified to allow for flexibility in modifying the formulation if there are changes in the relative prices of the different ingredients over time. The proposal also should contain estimates of the additional capital costs required for modifying all commercial flour mills to produce composite flours, the costs of fortifying the present wheat grind (about 50 percent of flour consumption) and the costs of fortifying all flour consumed in Bolivia, assuming it were milled locally. It is assumed that these additional costs would have to be borne by the government.

Phases I and II are expected to be completed during the first year.

PHASE III. During the second year of the program, provide continuing technical assistance to the flour milling and baking industries, to soybean processors, to rice and corn processors, if necessary, and to the Department of Technology, to assist in the implementation and enforcement of a countrywide flour fortification program in Bolivia.

Appendix B-3

PROJECT DESIGN - REGIONAL

IMPROVING THE NUTRITIVE VALUE OF WHEAT FOODS IN BOLIVIA

February 18, 1978

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PROJECT DESIGN - REGIONAL

IMPROVING THE NUTRITIVE VALUE OF WHEAT FOODS IN BOLIVIA

February 18, 1978

I. INTRODUCTION

This project between a) The Ministry of Industry, Commerce, and Tourism (MICT); the Ministry of Planning and Coordination (MIN PLAN); and the Ministry of Finance, agencies of the Government of Bolivia (GOB), and b) the Agency for International Development/Bolivia (USAID/Bolivia); and the Western Regional Research Center, United States Department of Agriculture (working under PASA # 931-11-560-231-73-3168048), agencies of the Government of the United States provides technical assistance and funds from Western Regional Research Center through its PASA #931-11-560-231-73-3168048 in order to establish the project "Improving the Nutritive Value of Wheat Foods in Bolivia", the purpose of which is to utilize the domestic crops of soy, rice and quinoa to provide substantial protein nutritional improvement of the wheat foods, bread, pastas, crackers, etc.

II. PROJECT PURPOSE AND OBJECTIVES

II.1. PURPOSE

The purpose of the project is to improve the nutritional status and well being of the people of Bolivia by:

II.1.1. Improving the protein nutritional quality and quantity of all wheat foods through the appropriate blending of the flours of wheat, soy, rice and quinoa.

II.1.2. Stimulating domestic agriculture and agribusiness to meet the new market demands for soy, rice and quinoa which result from the introduction of the composite flours.

II.2. GOAL

The goal is the commercial production throughout the nation of highly nutritious composite flours utilizing wheat, soy, rice and quinoa. A minimum increase of 20% in the protein content of the blends relative to wheat flour is sought. The composite flours will be used in the manufacture of all the traditional wheat foods such as bread, pastas, and crackers and the acceptability of these foods shall not be diminished.

II.3. PROJECT PHASES

The execution of the project falls into three phases:

II.3.1. First phase. Development of appropriate composite flour formulations.

II.3.2. Second phase: National feasibility determination of composite flours including trial production and market testing.

II.3.3. Third phase. Introduction of the new composite flours and processes on a National scale.

II.4. ACTIVITIES

II.4.1. First phase. Development of appropriate composite flour formulations.

II.4.1.1. Adequate laboratory facilities for composite flour research and development will be designed and installed at MICT.

II.4.1.2. Develop formulations of composite flours based on wheat, soy, rice and quinoa for use in a National program.

II.4.1.3. The tecnicians of the Division of General Standards and Technology (DGNT) working on the project will investigate and develop skills in all the technologies of composite flours identifying the most appropriate mixtures of wheat, soy, rice and quinoa and making sure that these blends are optimized with respect to:

a) Maximum nutritional quality

b) Acceptability

c) Industrial and economic feasibility

d) Minimum cost

e) Agricultural supply

II.4.2. Second phase. National feasibility determination of composite flours including trial production and market testing. Several major tasks must be completed satisfactorily in this test and evaluation phase:

II.4.2.1. Commercial trail of composite flours preparation.

II.4.2.2. Test suitability of composite flours in commercial baking and pasta manufacture under the direct guidance of project members.

II.4.2.3. Distribute composite flours samples to other bakers and pasta producers for their evaluation and comment.

II.4.2.4. Market acceptance determination of end use products such as bread and pastas.

II.4.2.5. Economic analysis and availability of supplies.

II.4.2.6. Development of a National Plan for Introduction of Composite Flours.

Entailed in the first four tasks (II.4.2.1.-4) are a number of important sub tasks. Because composite flours do not now exist in Bolivia on a commercial scale, and because much of the physical equipment and management infrastructure does not now exist for

composite flours, MICT will have to provide the coordination and impetus to plan and have carried out the procedures to:

a) Produce soy, rice and quinoa flour of appropriate quality.

b) Plan for transportation, storage, quality control and inventory build-up in order to insure a normal supply.

c) To provide for blending capacity at wheat mills.

d) To provide training for end use product manufacturers if the composite flours require changes in their formulas or manufacturing processes.

e) To consider financing of capital and inventory requirements.

The first four tasks (II.4.2.1-4) can be regarded as a demonstration which if successful provides a more suitable model for economic analysis. If the economic analysis and supply situation are positive, MICT would prepare a plan for National introduction of composite flours and present it to CONEPLAN and other agencies as required for approval.

II.4.3. Third phase. Introduction of the new composite flours and processes on a National scale.

The introduction of composite flours on a National scale is a complex undertaking requiring the availability of agricultural resources and their

marketing structure, installation of processing capacity, trial operations, storage and inventory, credits, product specifications and regulations, training of bakers and pasta manufacturers on the use of the new composite flours, and public promotion and information dissemination. Agricultural and Industrial interests will be reticent to invest in the necessary inputs, equipment and process modifications for composite flours unless they can be guaranteed a market for their products. Accordingly, a period of good faith bargaining is visualized where the appropriate agricultural groups and industries are identified and asked to submit their intents, backed-up with detailed planning, to make necessary plantings of crops, investment in equipment and changes in processes if the Government, in its part, would provide the realistic guarantees of appropriate markets. The mechanism for this guarantee would be a GOB decree requiring a National program of composite flours and backed-up by its detailed, realistic plan of implementation. At this point, the following requirements are identified:

II.4.3.1. Planting of sufficient soy, rice and quinoa to meet the new demands for composite flours.

II.4.3.2. Installation of the necessary equipment for the production of defatted soy flour suitable for human consumption.

II.4.3.3. Construction of a suitable plant to produce food grade rice flours or alternatively, to provide food grade rice of suitable physical characteristics to be used directly at the flour mills.

II.4.3.4. Utilization of the quinoa flour expected from the Ferrari Ghezzi plant currently under construction near Oruro.

II.4.3.5. Installation at each of the commercial wheat mills of appropriate storage capacity of soy, rice and quinoa flour and the installation of handling and blending capacity to add the soy, rice and quinoa and other additives in the wheat flour.

II.4.3.6. Development and preparation by MICT of a mechanism (possibly seminar/workshops) to assist bakers and pasta manufacturers adopt the new composite flour.

II.4.3.7. Development by MICT of a mechanism of composite flour regulation.

II.4.3.8. Development by MICT of a mechanism for the purchase and import of wheats of suitable quality for composite flours.

II.4.3.9. Development of a plan for public promotion and information dissemination on the composite flour program and the arrangement for its execution.

III. PROJECT SETTING AND BACKGROUND

III.1. NUTRITIONAL SITUATION

A sound base exists for planning and developing nutrition programs in Bolivia. This includes a recent GOB Five Year (1976-1980) Food and Nutrition Plan, a well defined infrastructure within the GOB for planning national nutritional strategy, and close cooperation between the GOB and USAID/Bolivia in the areas of health and nutrition. USAID/Bolivia has recently completed Health, Nutrition and Agricultural Assessments. Protein calorie malnutrition among children and anemia in pregnant and lactating women are seen as the primary nutritional problems followed by goiter (iodine) and certain vitamin deficiencies. The public health status is poor. Infant mortality estimates range from 145 to 250 per 1000 live births.

A study of the cities of La Paz and Viacha showed 41 to 47% of under age 5 deaths were cases in which malnutrition and immaturity were underlying or associated causes.

The Five Year (1976-1980) National Food and Nutrition Plan defines target groups for nutritional intervention programs as children under 5, pregnant and lactating women, and school children 5 to 15 with emphasis on the rural area. The plan's general goals are to meet the basic food needs of the people, to increase production of local food stuffs and to decrease the incidence of nutritional

deficiences such as PCM. A specific goal is to reduce by 20% the total protein and energy requirements currently met by imported foods.

The daily consumption of wheat in the Altiplano, Valleys, and Lowlands are 207,153, and 145 g respectively (GOB; 1976-1980 Food and Nutrition Plan). About 20% of the wheat will not be fortified because it does not enter the commercial milling market where the fortification will take place. If the remaining 80% of the wheat flour is fortified at the goal of a 20% increase in the protein content, then the increase in daily consumption of protein will be 3.3, 2.4 and 2.3 g. respectively. A goal of the GOB 1976-1980 Food and Nutrition Plan is to increase daily consumption of protein from 48 g.to 56 g. It can be seen that the wheat fortification project could provide 3/8 or about 40% of desired increase in protein consumption.

III.2. AGRICULTURAL SITUATION

Although agriculture is the main source of employment (65% of work force), a major source of domestic income, and a small export earner, there is considerable under employment in the agriculture sector, especially among the small farmers of the altiplano and valles. This has resulted in an outmigration from these areas to urban areas where these rural migrants generally have

difficulty finding employment. Because of the limited capacity of the urban areas to absorb these migrants, the government is attempting to expand agricultural employment opportunities and to encourage migration to areas which have the greatest potential for agricultural development but which are now the least populated. Increasing production and use of local crops such as soy and rice that could be substituted for part of the large imports of wheat would assist in this effort. For several years, the GOB and USAID cooperated in a project to attempt to increase wheat production, but generally this effort has met with little success. Attempts are also being made to increase production of other crops and there has been a marked success in increasing rice production and limited success in initiating soy production. Rice production increased from 39,500 MT in 1963 to 110,500 MT (unhulled) in 1977. Soy production in the years 1974, 1975, 1976 and 1977 has been 8,000 MT, 11,930 MT, 15,370 MT and 9,100 MT respectively. Inadequate markets for soy meal by-product appears to be the major constraint with regard to soy. However, with cotton prices

dropping and with adequate soy processing capacity, the out look for the soy crop to be planted October-December 1977 is good.

In 1976, the GOB published a five-year Agriculture Plan, some of the objectives of which are to assist in increasing internal production of agricultural commodities, especially by small farmers; to increase self-sufficiency of the food supply; to move toward equal development of all regions; and to reduce underemployment and make better use of natural resources.

III.3. <u>CONSUMPTION OF WHEAT FOODS</u>

Reports from a number of sources indicate the wheat consumption, especially in the form of bread, is important throughout the country and for all income groups. A recent Household Economic Survey by INE apparently confirms this, although as of February 1977 published data from this survey were not available. Data from an earlier (MACA/Utah State 1972) study indicate that there is widespread consumption of wheat foods throughout the country.

In the same study, it was found that in rural areas more of the households purchased rice in a given time period than either flour, bread, or noodles, but quantities were not specified. Other data from the study indicate that commercially produced bread is the most popular form of wheat food.

Average per capita use of wheat is around 135 pounds per year, mostly in the form of commercially made bread. Most bread is made from 72 percent extraction flour and in most regions there is reportedly a preference for white bread.

III.4. WHEAT FOOD INDUSTRIES

Although about 70,000 MT of wheat are domestically produced each year only about 12,000 MT enter into commercial milling channels. Because of the large per capita consumption of wheat foods, the equivalent of 250,000 MT of wheat is imported annually. About half of this is imported in the form of wheat and the other half in the form of flour. The commercial wheat milling industry consists of 13 mills widely scattered throughout the country, especially in the most densely populated areas. These mills have milling capacities ranging from 10 to 170 MT of wheat per day, with a total annual milling capacity of 182,000 MT. Only about 75 percent of the milling capacity is utilized.

Although the government controls imports by issuing import licenses to millers, it is usually more profitable to import flour than wheat; therefore, much contraband flour comes into Bolivia from Argentina and Brazil. The GOB is attempting to reduce, and eventually eliminate, flour imports by 1979 by more control and surveillance, and by encouraging the milling industry to increase the capacity of existing mills. Flour from the mills is sold to warehouse operators

who in turn sell to bakers, noodle makers or to the retail trade for household use. The baking industry of Bolivia can best be described as one of small scale artisans though there are several industrial bakers in La Paz and other cities. The Ministry of Industry licenses the small bakers under a handicraft category. Handmade bread is estimated to be 90 percent of the total. The common bread piece, the marraqueta, is 60 grams and the fixed price is $b. 0.5 (about U.S. 2.5cents). Because price is the major determinant in purchasing imported wheat, and little or no blending is done, there is a wide variation in the quality of flour (protein content may vary from 9 to 14 percent). Under these conditions, bakers presumably are accustomed to a wide range of performance characteristics for bread doughs and, therefore, could probably adjust to any baking performance effects that may result by addition of fortificants or extenders to wheat flour. The DGNT, MICT has completed a report "An Analysis of the Milling, Pasta, Cracker and Bread Industries", 1977.

III.5. POTENTIAL FOR LOCALLY AVAILABLE FORTIFICANTS AND EXTENDERS

In a 1976 GOB, Interamerican Development Bank and Institute of Inter American Agricultural Sciences study, the potential for soybean production in Bolvia was indicated as positive. Also past experience has shown that soybeans can be produced in substantial quantities with appropriate financial incentives. By one report, 45,000 hectares of land was unused in the Santa Cruz area in 1976 that could have grown soybeans. The 1977 soy planting out look in Santa Cruz, indicated by one large soy processor, is 18,000 hectares yielding 36,000 MT. There are two large, modern solvent extraction oilseed processing plants in Bolivia; SAO, a private plant in Santa Cruz and FACSA a CBF (GOB) plant at Villamontes. The SAO plant has been operating routinely on cottonseed and soy for over a year. The FACSA plant will begin shake down runs on crude oil refining in October, 1977 and shake down crushing runs on 6,000 MT of soybeans in the January to April 1978 period. Neither plant has flash desolventizing equipment needed to produce food grade defatted soy flour. Estimates of $300,000 to $500,000 have been made to install the necessary equipment for producing about 100 MT per day of food grade soy flour. The establishment of a steady market for the soy flour residue from crushing soybeans would enhance the attractiveness of growing soybeans in Bolivia and improve the economic condition of the oil seed crushing mills which are greatly underutilized because of lack of material to crush.

Technology exists and is used elsewhere in the world for utilizing food grade soy flours in bread and pastas up to 12 percent. Because of a very high protein content of soy flour and because the amino acids of soybean complement

those of wheat, the protein nutritional quality of wheat products fortified with soy flour is greatly enhanced. Some locally grown commodities could be used as wheat flour extenders in conjunction with soy flour, to possibly reduce the total price of the composite flour and of course substitute for imported wheat. Most of these crops would require considerable development work and/or production increases before their use would be feasible. The exception to this is rice. The production of rice has been increasing in recent years and the current October 1977, 17,000 MT surplus is likely to be increased by another 15,000 MT from the 1977-78 crop. The low world prices and limited quality prevent its sale in international markets. This is a costly inventory for the country that the GOB would like to convert to cash. An advantage of rice as a possible flour extender is that its production is very stable; therefore its supply would be reliable for a fixed formulation composite flour. The processing of milled rice to make flour for use in composite flour is a known technology. ENA has indicated a strong interest in this potential market for their rice and would consider building a rice mill in the Santa Cruz area if the GOB were to specify a composite flour containing rice. The use of a 5% soy, 10% rice and 85% wheat flour would result in a blend having 16% more protein than 100%

wheat flour and its protein quality as measured by the "Protein Efficiency Ratio" would be increased by 60 to 80 percent over that of wheat flour.

A decree requiring 5 percent quinoa in all wheat flour was issued in 1975. During the two years 1974-75 a total of 18,000 quintals of quinoa flour was produced by Ferrari Ghezzi in Oruro and used in composite flours. However, the desaponification process was not entirely satisfactory from the standpoint of yield (25% processing loss) and incomplete removal of saponin which resulted in a residual bitterness in the quinoa. Ferrari Ghezzi closed down the operation in 1975 and no more quinoa flour was available in the country. Subsequently, Ferrari Ghezzi has developed a combination dry peeling-water washing process that is superior to the old dry peeling process and they are building a plant near Oruro to make desaponified quinoa and quinoa flour. The plant is expected on stream about October, 1978. Quinoa is an excellent product for blending with wheat as shown by previous Bolivian experience. In addition the quinoa increases the protein content of wheat flour and a high content of the amino acid, lysine, nutritionally complements wheat which is limiting in lysine. The high price incentives for quinoa in Peru have resulted in movement of quinoa into Peru reducing locally available supplies. With the limited

production of 10,000 MT of quinoa per year, only a small quantity can be expected to be available for a composite flour program initially.

The Western Regional Research Center of the United States Department of Agriculture under contract with USAID have prepared two reports on aspects of Composite flours as a result of an assessment team visit in February 1977: "Case for a Wheat Flour Fortification Program in Bolivia" and "Potential for Protein Fortified and Other Composite Flours in Bolivia". The DGNT prepared in 1976 a project proposal, "Composite Flour Project" which is in the early stages of implementation.

The Committee of Public Works, Santa Cruz commissioned a project on composite flours utilizing soy, corn, rice and yuca starch to determine technical feasibility. The report, "Estudio de Mezclas de Harinas" by Dr. Carlos A. Pardo was published by the Committee in 1977. These preliminary studies indicated excellent technical feasibility and consumer acceptance.

Initiation of effort on the part of the MICT is the result of a Presidential Mandate in September 1976 to the MICT to study the feasibility of soy, rice, and quinoa as components for composite flour in Bolivia.

IV. COURSE OF ACTION

IV.1. PROJECT DEVELOPMENT STRATEGY

The project is divided into three phases -1) Research and development, 2) Commercial testing, and 3) National implementation. The design of the project has been jointly prepared by the Division of Standards and Technology (DGNT), MICT; the Food and Nutrition Group, MINPLAN; and the Western Regional Research Center, USDA providing coordination and understanding at the earliest stage.

While the first two phases of this project are primarilly concerned with technical feasibility, it is a basic philosophy of the executors to integrate at all stages, at the appropriate levels of consideration, the agricultural supply and potential supply situation, economics, and nutritional considerations. Coordination with other GOB agencies is an integral effort of the project.

It is also a basic philosophy to obtain continuous and maximum feedback from the commercial parties that will eventually implement such a program. This will be obtained by continuous. informal dialogue and two formal seminar/workshops to disseminate development information to the interested parties such as millers, bakers, farm groups, Ministry of Agriculture and so forth, and elicit feedback.

The specifics of the third phase, "Introduction of the new composite flours and processes on a National scale", can only be determined upon completion of the first and second phases.

At the end of Phase II, then, a National Plan for Introduction of Composite Flours will be prepared. It is the intent of the executors of the project that all appropriate GOB agencies take part in the development of the Plan with the MICT providing leadership and coordination. Upon completion of the plan, MICT will present the plan to MINPLAN for ultimate consideration.

IV.2 GOB ORGANIZATION FOR THE PROJECT

The Division of Standards and Technology (DGNT) will be the Institution in charge of the coordination and execution of the project, "Improving the Nutritive Value of Wheat Foods". The organization of DGNT is shown in the attached chart (Appendix I). The Department of Technology, DGNT will be in charge of the execution of the project working with the Departments of Standards, and Quality Control, and with the Laboratories.

IV.2.1. Personnel assigned to the project

a) Ing. Carlos Cáceres, Project Manager and Director, DGNT.	50% Time
b) Ing. Roberto Espinoza G., Project Technical Director and in charge of wheat and Quinoa flour studies. Industrial Engineer with studies in Food Technology.	100% Time
c) Ing. Emelina Reguerin, In charge of flour studies. Chemical Engineer with studies in the technology of Edible oils.	100% Time

d) Ing. Jorge Joffre, In charge or rice flour studies. Industrial Engineer.

e) Ing. Edgar Miranda, In charge of product development based on composite flours. Chemical Engineer with studies in Food Technology. 100% Time

f) Two chemistry technicians, one biochemist; chemical analyses. 100% Time

g) Three support personnel; Quality Control, 50% Time

Standards 50% Time

and Secretarial 100% Time

IV.2.2. DGNT laboratory equipment and materials.

Equipment and materials are available for the physical, chemical and microbiological analysis to be used in the project. The laboratories of the DGNT are adequately equipped for the analysis and control of those foods to be utilized.

IV.2.2.1. DGNT Cereal equipment

a) Brabender Farinograph with bath

b) Brabender Amylograph

c) Extensograph

d) Grain cleaner

e) Brabender Moisture meter

f) Balances (200-1000 grams)

IV.2.2.2. Physical facilities.

The DGNT presently has sufficient space for the functioning of the equipment to be used in this project. In the near future the DGNT will have another building for all its offices and laboratories that are now separated.

IV.3 WRRC ORGANIZATION FOR THE PROJECT

IV.3.1. Introduction: WRRC is a large agricultural research center, funded and operated by the United States Department of Agriculture.

It is located at 800 Buchanan St., Albany, California 94710, USA. WRRC has entered into a Participating Agency Service Agreement (PASA # 931-11-560-231-73-3168048) with the Technical Assistance Bureau, USAID/Washington wherein funds made available by USAID are to be used by WRRC to implement two projects around the world on "Improving the Nutritive Value of Wheat Foods" The PASA was signed June 1976 and extends through April 1979.

IV.3.2. Permanent WRRC, PASA Menbers Assigned to the Bolivian Project

a) Dr. David A.Fellers,Project Manager and Food Technologist. — 50% Time

b) Mr.Roberto V.Enochian,Agricultural Economist and Market specialist. — 12.5% Time

c) Dr.Antoinette A.Beschart,Nutritionist — 12.5% Time

d) Ms.Maura M.Bean, Baking Technologist. — 12.5% Time

e) Mr.Allan D.Sheperd,Food Technologist. — 12.5% Time

f) Mrs.Virginia Nelson, Secretary — 25% Time

The PASA provides funds for the salaries, benefits, travel, and per diem of the WRRC team members.

IV.3.3. Consultant capability. The PASA provides funds for the hire of U.S. consultants to complement the WRRC expertise. Consultants will be used when neither WRRC nor GOB can provide the needed Technical Assistance from their own organizations.

IV.3.4. WRRC laboratory capabilities. The laboratories of WRRC are staffed by over 150 senior scientists plus Technical and staff support and have extensive capabilities including a complete baking laboratory,

pilot plants including a pasta extruder, and routine and sophisicated physical, chemical, nutritional, and microbiological analysis. The nutritional capability includes animal studies. It is the intent to utilize these facilities only to the extent that the necessary operations can not be carried out in the host country by the project counterpart organizations.

IV.3.5. Local funds. The PASA has reserved funds for use in the host country to provide minor equipment, ingredients, services and contracts as jointly determined by WRRC and the GOB counterparts but subject to approval of the WRRC project manager or his authorized agent and subject to the legal restrictions otherwise in effect by the GOB, U.S. Government or bilateral or international treaties.

IV.4. MAJOR PROJECT COMPONENTS AND FINANCIAL SUPPORT; OCTOBER 15, 1977 THROUGH APRIL 30, 1979.

IV.4.1. GOB

IV.4.1.1. Personnel; 11..........Cost $ 101,900

IV.4.1.2. Office Supplies and maintenance............Cost $ 5,500

IV.4.1.3. Laboratory equipment and supplies (already on hand)...............Cost $ 70,000

IV.4.1.4. Cereal Laboratory equipment (already on hand)..Cost $ 50,000

IV.4.1.5. Cash contribution..... Cost $ 11,000

a) Raw materials

b) Reagents and additives

c) Additional equipment

d) Travel and per diem

e) Transportation of equipment and materials

f) Rental of commercial baking and pasta equipment and facilities during industrial tests. ___________

IV.4.1.6. Total Cash or equivalent.Cost $ 238.400

IV.4.1.7. Supporting Institutions

a) National Rice Agency (ENA) will provide rice samples for the investigative stages.

b) Minsitry of Health - will participate through its Department or Nutrition, advising on composition and nutritional value of foods under investigation.

c) Ministry or Agriculture - will advise on the production and potential producton of wheat, soy, rice and quinoa.

d) Division of Industry, MICT - will coordinate and facilitate the industrial implementation in all the

firms involved in the production of composite flours and their use in products.

e) Division of Interior Commerce - will provide information on processing and marketing of wheat, wheat flour, soy, rice and quinoa, and on imported wheat and wheat flour and in conformity with the results obtained in the investigation, will be the entity that regulates the supplies of wheat, soy flour, rice and quinoa and the supply of composite flours.

f) Oil Company of the East (S.A.O.) - a private firm that will provide soy flour for the investigation, and which has an estimate for the additional equipment needed for production of food grade soy flour.

g) Ferrari Ghezzi - a milling company that will provide quinoa flour for the investigation, and also being the firm that is currently constructing a commercial quinoa processing plant of improved design.

IV.4.2 WRRC

IV.4.2.1.	Personnel; 5 part time..Cost	$ 70,000
IV.4.2.2.	Travel and per diem.....Cost	$ 20,000
IV.4.2.3.	Consultants including expenses................Cost	$ 15,000
IV.4.2.4.	WRRC Overhead to include use of laboratory facilities, supplies, maintenance, utilities, etc.................... Cost	$ 45,000
IV.4.2.5.	Contributed baking equipment (purchased in the U.S.)...........Cost	$ 15,000
IV.4.2.6	Local costs.............Cost	$ 35,000
	a) Minor equipment	
	b) Raw materials	
	c) Services and rentals	
	d) Contracts	
IV.4.2.7	Total Cash or equivalent Cost	$ 200,000

IV.5. IMPLEMENTATION PLAN

IV.5.1. Schedule of major events.

Phase I. Development of appropriate composite flour formulations.

a) Prepare and sign Project Agreement.

b) Collect and characterize as to general type, composition microbiological and physical attributes products of wheat, soy, rice and quinoa currently available in the market that are potentially suitable for use in composite flours.

c) Design baking laboratory, purchase and assemble equipment, prepare facilities for receipt, ship and install equipment.

d) Review world experience and develop approaches to prepare suitable flours from soy, rice and quinoa for composite flours or develop approaches to use rice and quinoa products directly in the wheat milling process.

e) Obtain representative samples of wheat flour, soy flour, rice flour and quinoa flour and additives such as dough conditioners for composite flour formulation work and testing.

f) Develop and test composite flour formulations by physical, chemical, nutritional microbiological, and rheological means and by baking and pasta preparation. Optimum blends are choosen considering a balance of nutritional, functional, and organoleptic quality, industrial feasibility of production

and use, cost, and agricultural supply and potential.

g) Further develop and refine approaches to prepare, on an industrial basis, flours of soy, rice and quinoa using the requirements determined for these flours during the formulation development and testing period.

h) Prepare tentative specifications for the flours of soy, rice and quinoa and the choosen blends.

i) Hold a seminar/workshop to desseminate first phase results and recommendations to interested parties such as millers, pasta producers agricultural groups, and nutrition oriented groups.

j) Evaluate the work of the first phase and prepare a final report.

Phase II. National feasibility determination of composite flours including trial production and market testing.

a) Determine availability and prepare market analysis of raw materials, composite flours and finished products calling on the resources of the Ministry of Agriculture, MICT and others.

b) Arrange with a commercial mill for commercial trial preparation of composite flours. Assemble necessary ingredients at the mill. Arrange for the packaging and storage of the composite flours.

c) Carry out the commercial trial preparation of composite flour.

d) Evaluate process and blends; repeat b and c if necessary.

e) Test prepared blends in 4 bakeries (an industrial level and a handicraft level bakery in Santa Cruz and an industrial level and handicraft level bakery in La Paz --altitude effects), in one cookie operation and in one pasta operation.

f) Train several bakers and pasta makers on the use of the new composite flours in preparation for trial use in their operations.

g) Distribute samples of composite flours to the trained bakers and pasta makers for their use, evaluation and comment under the general guidance of the technicians of the project.

h) Design a consumer market test.

i) Arrange for details of the market test, carryout, and evaluate.

j) Prepare a technical-economic analysis of composite flours (using all the accumulated experience) for introduction into the national market.

k) Jointly develop a National Plan for Introduction of Composite Flours calling on the resources of industry, Ministry of Agriculture, Ministry of Health, MINPLAN, MICT and others as required.

l) Arrange a seminar/workshop to desseminate the second phase results and recommendations to the interested parties.

Phase III. Introduction of the new composite flours and processes on a National scale. The implementation of the National Plan for Introduction of Composite Flours will be the result of the previous two phases. In this phase, it is necessary to have active participation of public and private institutions. The areas and responsibilities necessary for success of the Plan must be specified. The Plan should contain all the actions necessary for the introduction of the composite flours in the national market. Some of these actions are detailed as follows:

a) Planting of sufficient soy, rice and quinoa to meet the new demands for composite flours.

b) Installation of the necessary equipment for the production of defatted soy flour suitable for human consumption.

c) Construction of a suitable plant to produce food grade rice flours or alternatively, to provide food grade rice of suitable physical characteristics to be used directly at the flour mills.

d) Utilization of the quinoa flour expected from the Ferrari Ghezzi plant currently under construction near Oruro.

e) Installation at each of the commercial wheat mills of appropriate storage capacity of soy, rice and quinoa flour and the installation of handling and

blending capacity to add the soy, rice and quinoa and other additives in the wheat flour.

f) Development and preparation by MICT of a mechanism (possibly seminar/workshops) to assist bakers and pasta manufacturers adopt the new composite flour.

g) Development by MICT of a mechanism of composite flour regulation.

h) Development by MICT of a mechanism for the purchase and import of wheats of suitable quality for composite flours.

i) Development of a plan for public promotion and information dissemination on the composite flour program and the arrangement for its execution.

IV.5.2. PERT CHART FOR THE PROJECT, "IMPROVING THE NUTRITIVE VALUE OF WHEAT FOODS IN BOLIVIA"

			1977			1978												1979			
		ACTIVITIES	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Phase I Development	a	Prepare Agreement	XXXX																		
	b	Collect-characterize samples	XXXXX	XXXXXX																	
	c	Develop baking laboratory	XX	XXXXXX	XXXXXX																
	d	Methods of producing flours	XXXXX	XXXXXX	XXXXXX																
	e	Obtain soy,rice,quinoa flours	XX	XXXXXX	XXXXXX																
	f	Develop and test blends				XXXXX	XXXXXX	XXXXX	XXXXX	XXXXXX											
	g	Ind. prep. of various flours								XXXXX	XXXXXX										
	h	Specifications of blends, etc.								XXXXX	XXXXXX										
	i	Seminar/workshop									XXXXXX										
	j	Evaluation and report									XXX	XXX									
National Phase II Feasibility	a	Market analysis					a	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX									
	b	Assemble ingredients, etc.									b	XXXXX									
	c	Commercial blend prep.										c XX	XXXXXX	XX							
	d	Evaluate process and blends											d XX	XXXXXX	XXXX						
	e	Test blends in bakeries, etc.												e XX	XXXXXX						
	f	Train bakers													f XX	XXXX					
	g	Bakers test composite flours													g	XXXXXX					
	h	Design market test											h	XXXXXX	XXX						
	i	Carryout market test													i XX	XXXXXXX	XXX				
	j	Tecnical-economic analysis										j	XXXXX	XXXXXX	XXXXXX	XXX					
	k	National Implementation Plan														k XX	XXXXXX				
	l	Seminar/workshop														l	XXXXXX				
Phase III		To be detailed in the National Plan for Introduction of Composite Flours; however, hypothesized schedule of activities is presented on page 31-B.																XXXXX	XXXXXX	XXXXX	XXXXXX

PERT CHART cont'd. SCHEDULE OF HYPOTHESIZED ACTIVITIES IN PHASE III[1/]

			1979												1980			
		ACTIVITIES	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Phase III Introduction of The New Composite Flours and Processes on a National Scale	a	Planting of soy, rice, and quinoa																
		1. Agricultural credit decisions		XXXXX	XXXXX													
		2. Seeding through harvest									a-2	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	b	Equipment installation for food-grade soy flour																
		1. Decision and purchase orders	XXXXX															
		2. Installation and shakedown runs									b-2	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX		
	c	Rice flour production capability																
		1. At wheat flour mills[2]																
		2. Separate plant	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX		
	d	Utilization of Quinoa flour[3]	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	e	Wheat mill modifications for composite flours																
		1. Quinoa flour production capacity[4]																
		2. Storage capacity for soy flour, rice, quinoa	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX				
		3. Development of blending capacity						e-3	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX		
		4. Inventory build-up; soy flour, rice, quinoa												e-4	XXXXX	XXXXX	XXXXX	XXXXX
	f	Training of bakers, pasta producers												f	XXXXX	XXXXX	XXXXX	
	g	Develop composite flour regulation capability												g	XXXXX	XXXXX	XXXXX	
	h	Implement program of quality wheat purchases							h	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	i	Public information dissemination														i	XXXXX	XXXXX
	j	Introduction of protein-fortified wheat products in consumer markets															j	XXXXX

1) WRRC's PASA terminates April 30, 1979. The extension of the PERT Chart beyond this date is for the purposes of planning and better understanding of the final results of the current project. It does not commit USAID/Bolivia or WRRC to participate beyond April 30,1979.

2) Rice can be milled with wheat by introducing the rice at the second break rolls -- thus the capacity already exists for producting rice flour except, perhaps, for the appropriate feeders.

3) A Bolivian Decree already exists allowing utilization of quinoa in wheat flour. Production capacity of desaponified quinoa is expected from the Ferrari Ghetzi plant currently under construction about October 1978.

4) The production of quinoa flour will probably be by introducing the desaponified quinoa seeds at the third break in the flour mill--thus the capacity to produce quinoa flour already exists except, perhaps, for appropriate feeders.

IV.6. EVALUATION PLAN

Three mechanisms will be considered for the evaluation of the project:

a) An internal DGNT evaluation.

b) A joint evaluation between DGNT, WRRC, and the Food and Nutrition Technical Group (FNTG) of MINPALN.

c) A National evaluation (Ministries of: Planning and Coordination; Industry, Commerce and Tourism; Social Welfare and Public Health Agriculture and Campesino Affairs; and Finance and USAID/Bolivia and WRRC).

IV.6.1. Internal DGNT evaluation.

This evaluation will be carried out by the techicians in charge of the project and by the office of the Director General, DGNT.

This will be a self evaluation of the progress on the project and also will have the purpose of determining any modifications or changes in the work plan in order to obtain the desired goal. Such changes will be coordinated with WRRC.

This evaluation activity will take place each month or at the end of each important activity identified in the PERT chart.

IV.6.2. Joint DGNT, WRRC, FNTG evaluation.

Evaluation will be by means of partial reports and meetings between DGNT and WRRC and where appropriate the FNTG. The reports will be on the results of each activity

identified in the PERT chart and on the results of investigations such as the physical-chemical and nutritional analyses of samples sent by DGNT to WRRC. Reports by advisors or technical experts are also included.

The activities evaluated by means of reports will be:

a) Installation and start-up of the baking laboratory. This will be a joint report of the DGNT and the baking expert.

b) Results of the investigations on composite flour formulations.

c) Conclusions of the seminar/workshop at the end of Phase I.

d) Final report of Phase I results with conclusions and recommendations.

e) Results of industrial level tests.

f) Results of the bakers training course.

g) Results of the consumer acceptability survey.

h) National Plan for Introduction of Composite Flours

i) Conclusions of the Phase II seminar/workshop.

j) Reports of experts: Baking expert; soy technologist, market research expert, agricultural economist and others.

k) Reports by the DGNT on the activities of the technical assistance experts.

IV.6.3. National evaluation.

This evaluation will consider the economic, social and technological effects which the implementation of composite flour based foods will bring. The means for this evaluation will be:

a) Seminar/workshop at the end of Phase I.

b) Seminar/workshop at the end of Phase II.

c) Participants in the preparation of the National Plan for Introduction of Composite Flours.

d) Impartial team of experts to decide on implementation of the "National Plan for Introduction of Composite Flours."

V. SPECIFIC COMMITMENTS

V.1. GOB

V.1.1. Pay for the air transport of laboratory baking equipment from Miami to La Paz via Lloyd Aereo Boliviano.

V.1.2. Prepare the facilities where the laboratory baking equipment will be installed.

V.1.3 Install the laboratory baking equipment.

V.1.4. Purchase raw materials such as: wheat flour, soy, rice, quinoa, additives, reagents and other materials required for the project. The acquisition of these materials will be effected according to the mutual agreement between DGNT and WRRC.

V.1.5. Pay the salaries of local personnel which work on the project.

V.1.6. Pay for required services such as: electricity, water, fuel and telephone.

V.2. WRRC/USAID

V.2.1. Assess the available laboratory scale baking equipment in the market and design a functional baking laboratory for the DGNT.

V.2.2. Purchase up to $ 15,000 of equipment necessary to establish a functioning baking laboratory within the facilities of the DGNT.

V.2.3. Assemble the baking equipment at Miami, Florida for trans-shipment to La Paz via Lloyd Aereo Boliviano.

V.2.4. Provide a baking expert for up to one month to assist the DGNT establish a functioning baking laboratory and to provide training to the technicians of the DGNT on the use of various baking and cereal testing equipment. The likely time for this activity will be the month of April 1978.

V.2.5. Provide a baking expert for up to one month in the latter stages of the development of composite flour formulations and during the evaluation of these formulations to assist in the selection of the most appropriate blends for the second phase work. The likely time for this activity will be June-July 1978.

V.2.6. Provide support in the area of nutritional planning and in nutritional analyses of ingredients, composite flours and final products.

V.2.7. Provide an expert soy technologist both in the areas of laboratory procedures for evaluating and controlling quality of soy flours and in industrial procedures in order to build up the expertise of the DGNT in this area so critical to the success of the composite flour program.

V.2.8. Provide imported, defatted, food grade soy flour needed in the investigative and technical feasibility studies.

V.2.9. Provide a market research expert to assist in the design of the market acceptance test for composite flour products.

V.2.10. Agrees to consider further requests for technical assistance in such areas as:

V.2.10.1. Milling expert --especially as would relate to conversion of mills to produce composite flours.

V.2.10.2. Baking expert to establish a training program in composite flour use.

V.2.10.3. Support and participate in the seminar/workshops at the completion of phase I and phase II.

V.2.10.4. Provide an economist to support the economic analysis toward the end of phase II.

V.2.10.5. Consult in the development of the National Plan for Introduction of Composite Flours.

V.2.11. Will support the translation of major reports so that all major reports will exist in both Spanish and English.

VI. <u>SPECIAL PROVISIONS</u>

VI.1. GOB

WRRC or USAID shall not release information on the project to the popular press without prior authority from the Director General of DGNT, MICT.

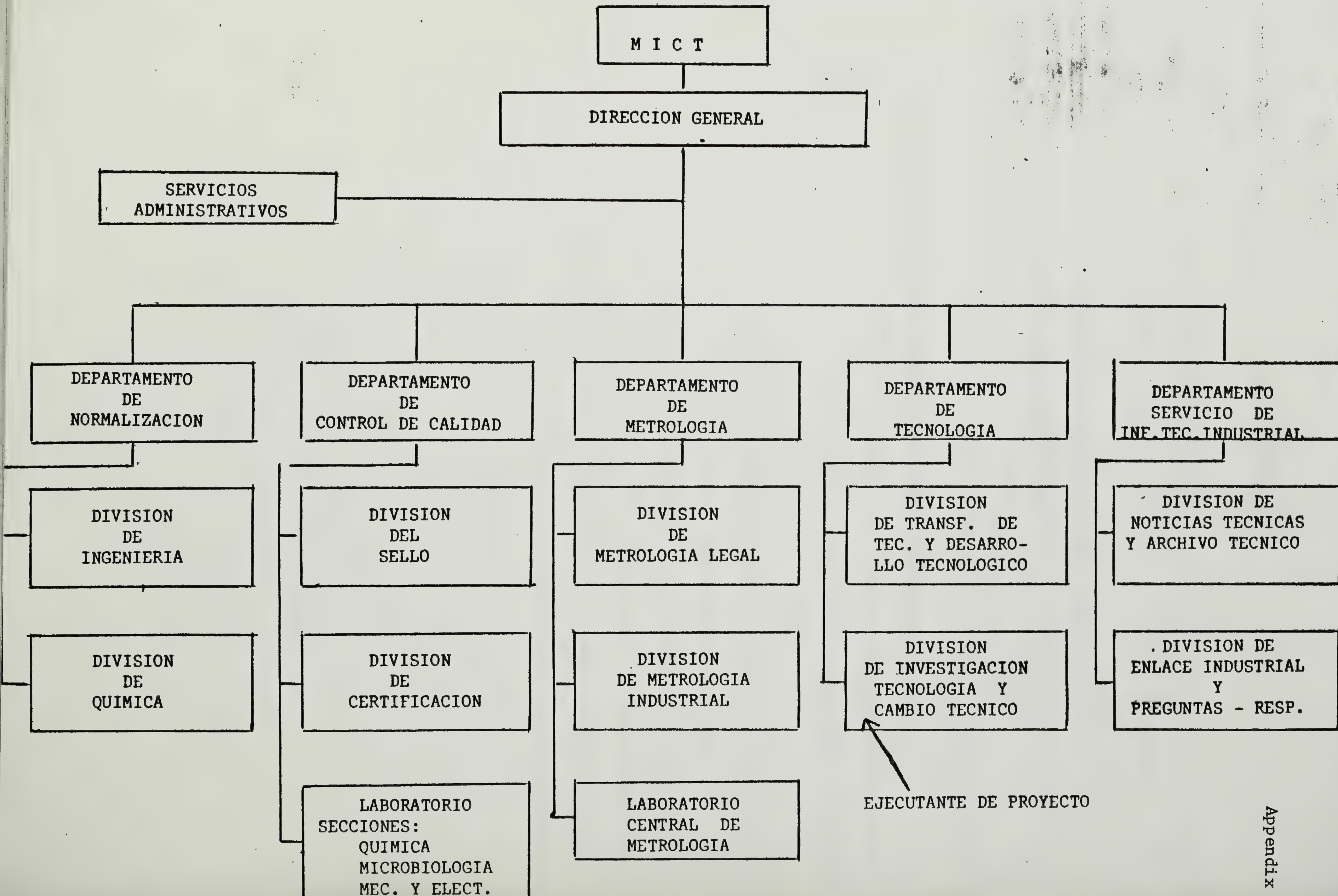
VI.2. USAID

USAID/B requests two copies of each Report listed in Section IV.6.2.

Appendix B-3

DIRECCION GENERAL DE NORMAS Y TECNOLOGIA

(APPENDIX 1)



Appendix B-4

PROJECT GRANT AGREEMENT

DATED: June 22, 1978

Between the Republic of Bolivia ("Government") and the United States of America, acting through the Agency for International Development ("A.I.D.")

Article 1: The Agreement

The purpose of this Agreement is to set out the understandings of the parties named above with respect to the undertaking by the Government of the Project described herein and with respect to the financing of the Project by the Parties.

Article 2: The Project

Section 2.1. - Definition of Project. The Project, which is further described in Annex 1, seeks on a National basis to improve the nutritional status and well-being of the people of Bolivia by improving the protein nutritional quality and protein quantity of wheat foods through the appropriate blending of the flours of wheat, soy, rice and quinoa and by stimulating domestic agriculture and agribusiness to meet the new market demands for soy, rice and quinoa which result from the introduction of the composite flours.

It is a goal of the project to develop composite flours that have 20% higher protein content than wheat flour and when these composite flours are used to prepare bread, pastas and crackers, the acceptability of these end-use foods shall not be diminished. The project has three

phases:

1) development of appropriate composite flour formulations, 2) national feasibility determination of composite flours including trial production and market testing, and 3) introduction of the new composite flours and processes on a national scale subject to results of evaluation. In addition to internally established evaluations, there shall be an evaluation at the end of Phase 2 by a group of impartial experts to decide on implementation of the third phase. The major project expediter and coordinator is the Ministry of Industry, Commerce and Tourism. The Western Regional Research Center (WRRC), United States Department of Agriculture, provides technical assistance and funds working through its agreement (PASA) with AID's Development Service Bureau (DSB).

Annex 1, attached, amplifies the definition of the project contained in this section 2.1. Within the limits of the definition of the project in this Section 2.1., elements of the amplified description stated in Annex 1 may be changed by written agreement of the authorized representatives of the parties named in Section 8.3. without formal amendment of this Agreement.

Section 2.2. - <u>Non-incremental Nature of Project</u>

(a) No additional USAID funding beyond that provided herein will be made available under this project.

(b) In the event that AID does not provide contemplated funding in a timely fashion, it is understood that either party may elect to

terminate this Agreement in accordance with Grant Project Standard Provisions Annex Article D, Section D.1; provided, however, that within the limits of then available funds committed to the Project by the parties, the termination period may be extended beyond a period of 30 days to provide for orderly arrangements, and that each party will do all it believes appropriate to retain and extend the benefits of Project activity which has already taken place.

(c) Within the overall Project Assistance Completion Date as defined in Section 3.3. of this Agreement and upon consultation with the Government, AID may specify in Project Implementation Letter appropriate time periods for the utilization of funds granted by AID under this Agreement.

Article 3: Financing

Section 3.1. - The Grant. To assist the Government to meet the costs of carrying out the Project, AID/DSB agrees to grant the GOF under the terms of this Agreement the amount not to exceed $200,000 United States Dollars. (The "Grant").

The Grant may be used to finance Foreign Exchange Costs, as defined in Section 6.1., and Local Currency Costs, as defined in Section 6.2., of goods and services required for the Project.

Section 3.2. - Government Resources for the Project

(a) The Government agrees to provide or cause to be provided for the Project all funds in addition to the Grant and all other resources required to carry out the Project effectively and in a timely manner.

(b) The resources provided by Government for the Project will be not less than the equivalent of US$238,400, including costs borne on an "in-kind" basis.

Section 3.3. - Project Assistance Completion Date

(a) The Project Assistance Completion Date, which is April 30, 1979, or such other date as the parties may agree to in writing, is the date by which the parties estimate that all services financed under the Grant will have been performed and all goods financed under the Grant will have been furnished for the Project as contemplated in this Agreement.

(b) Except as AID/DSB may otherwise agree in writing, AID/DSB will not issue or approve documentation which would authorize disbursement of the Grant for services performed subsequent to the PACD for goods furnished for the Project, as contemplated in this Agreement.

(c) Requests for disbursement, accompanied by necessary supporting documentation prescribed in Project Implementation Letters, are to be received by AID or any bank described in Section 7.1 no later than nine (9) months following the PACD, or such other period as AID agrees to in writing. After such period, AID, giving notice in writing to the Government, may at any time or times reduce the amount of the Grant, or to the issuance by AID/DSB of documentation pursuant to which disbursement will be made and within 90 days the Government will, except as the parties may otherwise agree in writing, furnish to AID/DSB in form and substance satisfactory to AID/DSB. A statement

of the names of the persons holding or acting in the office of the Government specified in Section 8.3., and a specimen signature of each person specified in such statement.

Section 4.2. - Notification - When AID/DSB has determined that the condition precedent specified in Section 4.1. has been met, AID/DSB will promptly notify the Government.

Article 5: Special Covenants

Section 5.1. - Project Evaluation. The parties agree to establish an evaluation program as an integral part of the Project. Except as the parties may otherwise agree in writing, the program will include, during the implementation of the Project and at one or more points thereafter: (a) an internal Directorate of Standards and Technology (DGNT) evaluation; (b) a joint evaluation between DGNT, WRRC and the Food and Nutrition Technical Group (FNTG) of the Ministry of Planning, and (c) a national evaluation with participation of the Ministries of Planning and Coordination; Industry, Commerce and Tourism; Social Welfare and Public Health; Agriculture and Rural Affairs; and Finance; and USAID/Bolivia and WRRC.

Article 6: Procurement Source

Section 6.1. - Foreign Exchange Costs. Disbursements pursuant to Section 7.1. will be used exclusively to finance the costs of goods and services required for the Project having their source and origin in the United States (Code 000 of the AID Geographic Code Book as in effect at the time orders are placed or contracts entered into for

such good or services) (Foreign Exchange Costs), except as AID/DSB may otherwise agree in writing, and except as provided in the Project Grant Standard Provisions Annex, Section C.1. (B) with respect to marine insurance.

Section 6.2. - Local Currency Costs. Disbursements pursuant to Section 7.2. will be used exclusively to finance the costs of goods and services required for the Project having their source and, except as AID/DSB may otherwise agree in writing, their origin in Bolivia ("Local Currency Costs")

Article 7: Disbursement

Section 7.1. - Disbursement for Foreign Exchange Costs

(a) After satisfaction of conditions precedent, the Government may obtain disbursements of funds under the Grant for the Foreign Exchange Costs of goods or services required for the Project in accordance with the terms of this Agreement, by such of the following methods as may be mutually agreed upon:

(1) by submitting to AID/DSB with necessary supporting documentation as prescribed in Project Implementation Letters, requests for reimbursement for such goods or services, or requests for AID/DSB to procure commodities or services in the Government's behalf for the project, or,

(2) by requesting AID/DSB to issue Letters of Commitment for specified amounts to one or more U.S. banks, satisfactory to AID/DSB, committing AID/DSB to reimburse such bank or banks for payments made by them to contractors or supplies, under Letters of Credit or otherwise,

for such goods or services, or directly to one or more contractors or suppliers, committing AID/DSB to pay such contractors or suppliers, through Letters of Credit or otherwise, for such goods or services.

(b) Banking charges incurred by Government in connection with Letters of Commitment or and Letters of Credit will be financed under this Grant unless Government instructs AID/DSB to the contrary. Such other charges as the parties may agree to may also be financed under the Grant.

Section 7.2. - Disbursement for Local Currency Costs

(a) The Government may obtain disbursements of funds under the Grant for Local Currency Costs required for the Project in accordance with the terms of this Agreement, by submitting to AID/DSB with necessary supporting documentation as prescribed in Project Implementation Letters, requests to finance such costs. The local currency needed for such disbursements may be obtained:

(1) by acquisition by AID/DSB with U.S. Dollars by purchase or from local currency already owned by the U.S. Government; or

(2) by AID/DSB requesting the Government to make available the local currency for such costs, and thereafter making available to the Government, through the opening or amendment by AID/DSB of Special Letters of Credit in favor of the Government or its designee; an amount of U.S. Dollars equivalent to the amount of local currency made available by the Grantee, which dollars will be utilized for procurement from the United States under appropriate procedures described in Project

Implementation Letters

The U.S Dollar equivalent of the local currency made available hereunder will be, in the case of subsection (a) (1) above, the amount of U.S. dollars required by AID/DSB to obtain the local currency, and in the case of subsection (a) (2) above, an amount calculated at the rate of exchange specified in the applicable Special Letter of Credit Implementation Memorandum hereunder as of the date of the opening or amendment of the applicable Special Letter of Credit.

Section 7.3 - Other Forms of Disbursement. Disbursement of the Grant may also be made through such other means as the parties may agree to in writing

Section 7.4. - Rate of Exchange Except as may be more specifically provided under Section 7.2., if funds provided under the Grant are introduced into Bolivia by AID or any public or private agency for purposes of carrying out obligations of AID hereunder, the Government will make such arrangements as may be necessary so that such funds may be converted into currency of Bolivia at the highest rate of exchange available to AID which, at the time conversion is made, is not unlawful in Bolivia

Article 8: Miscellaneous

Section 8.1. - Communications. Any notice, request, document or other communication submitted by either party to the other under this Agreement will be in writing or by telegram or cable, and will be deemed duly given or sent when deliverd to such party at the following addresses:

To the: Ministerio de Industria, Comercio y Turismo
Avenida Camacho esquina Bueno
La Paz

To AID: USAID Mission to Bolivia
c/o American Embassy
La Paz, Bolivia

Other addresses may be substituted for the above upon the giving of notice. In addition, the Government will provide the USAID Mission with copy of any communication sent to AID in Washington.

Section 8.3. - Representatives. For all purposes relevant to this Agreement, the Government will be represented by the individual holding or acting in the office of the Minister of Industry, Commerce and Tourism and AID will be represented by the individual holding or acting in the office of Mission Director, each of whom, by written notice, may designate additional representatives for all purposes other than exercising the power under Section 2.1. to revise elements of the amplified description in Annex I. The names of the representatives of the Government with speciment signatures, will be provided to AID, which may accept as duly authorized any instrument signed by such representatives in implementation of this Agreement, until receipt of written notice of revocation of their authority.

Section 8.4. - Standard Provisions Annex. A "Project Grant Standard Provisions Annex" (Annex 2) is attached to an forms part of this Agreement.

IN WITNESS WHEREOF, the Government and the United States of America, each acting through its duly authorized representative, have caused this Agreement to be signed in their names and delivered as of the

day and year first above written.

SIGNATORS:

REPUBLIC OF BOLIVIA

BY:
Title: Minister of Industry, Commerce and Tourism
Date:

BY:
Title: Minister of Planning and Coordination
Date:

BY:
Title: Minister of Finance
Date:

UNITED STATES OF AMERICA

By:
Title: Director, USAID/Bolivia
Date:

PROJECT DESCRIPTION

A. Introduction

The purpose of the project is to improve the nutritional status and well being of the people of Bolivia by: 1) Improving the protein nutritional quality and protein quantity in wheat foods through the appropriate blending of the flours of wheat, soy, rice, and quinoa and 2) Stimulating domestic agriculture and agribusiness to meet the new market demands for soy, rice and quinoa which arise from the introduction of the composite flours. The purpose will be achieved by the commercial production throughout the nation of highly nutritions composite flours utilizing wheat, soy, rice and quinoa.

A minimum increase of 20% in the protein content of the blends relative to wheat flour is sought. The composite flours will be used in the manufacture of all the traditional wheat foods such as bread, pastas, and crackers, and the acceptability of these foods shall not be diminished.

B. Project Phasing

The execution of the project falls into three phases:

1. Development of appropriate composite flour formulations.

In this first phase, adequate research laboratory facilities are completed, basic agricultural commodities of concern characterized, processes developed to convert them to useable forms, composite flours produced and tested in the laboratory, the best ones selected and described

by specifications, and accumulated information disseminated by seminar/workshop and Phase 1 Final Report.

2. National Feasibility Determination of Composite Flours including Trial Production and Market Testing

In the second phase, national markets are analysed, composite flours are prepared in commercial trials, tested in commercial bakeries and pasta plant and market tested. A technical-economic analysis is made and, if positive, will result in the preparation of a National Plan for Introduction of Composite Flours. Accumulated information is disseminated by the Plan and a seminar/workshop. Feed back is solicited for consideration in modifying the National Plan for Introduction of Composite Flours. The plan is then evaluated by an impartial team of experts to decide on implementation of the third phase. Major participants in this evaluation are Min Plan, MACA, Ministry of Health, Ministry of Finance, MICT, USAID/B, and WRRC.

3. Introduction of the New Composite Flours and Processes on a National Scale. In the Third phase, the National Plan for Introduction of Composite Flours is put into effect. It will entail such activities as insuring adequate crop production, processing and storage capacity for soy, rice and quinoa flours, transportation, handling and blending capacity at wheat mills, training for bakers, quality control and regulation, and dissemination of information and promotion in the population.

In order to complete the three project phases the following major events or activities are detailed:

Phase 1

a. Collect and characterize as to general type, composition, microbiological and physical attributes products of wheat, soy, rice and quinoa currently available in the market that are potentially suitable for use in composite flours.

b. Design baking laboratory, purchase and assemble equipment, prepare facilities for receipt, ship and install equipment.

c. Review world experience and develop approaches to prepare suitable flours from soy, rice and quinoa for composite flours or develop approaches to use rice and quinoa products directly in the wheat milling process.

d. Obtain representative samples of wheat flour, soy flour, rice flour and quinoa flour and additives such as dough conditioners for composite flour formulation work and testing.

e. Develop and test composite flour formulations by physical, chemical, nutritional, microbiological, and rheological means and by baking and pasta preparation. Optimum blends are choosen considering a balance of nutritional, functional and organoleptic quality, industrial feasibility of production and use, cost and agricultural supply and potential.

f. Further develop and refine approaches to prepare, on an industrial basis, flours of soy, rice and quinoa using the requirements

determined for these flours during the formulation development and testing periord.

g. Prepare specifications for the flours of soy, rice and quinoa and the choosen blends.

h. Hold a seminar/workshop to disseminate first phase results and recommendations to interested parties such as millers, pasta producers, agricultural groups, and nutrition oriented groups.

i. Evaluate the work of the first phase and prepare a final report.

Phase 2

a. Determine availability and prepare market analysis of raw materials, composite flours and finished products calling on the resources of the Ministry of Agriculture, MICT and others.

b. Arrange with a commercial mill for commercial trial preparation of composite flours. Assemble necessary ingredients at the mill. Arange for the packaging and storage of the composite flours. Carry out the commercial trial preparation of composite flour.

c. Evaluate process and blends; repeat if necessary.

d. Test prepared blends in 4 bakeries (an industrial level and a handicraft level bakery in Santa Cruz and an industrial level and handicraft level bakery in La Paz -- altitude effects), in one cookie operation and in one pasta operation.

e. Train several bakers and pasta makers on the use of the new composite flours in preparation for trial use in their operations.

f. Distribute samples of composite flours to the trained bakers and pasta makers for their use under the general guidance of the technicians of the project. Solicit their comments and evaluate.

g. Design, organize, implement and evaluate a consumer market test.

h. Prepare a technical-economic analysis of composite flours (using all accumulated experience) for introduction into the national market.

i. Jointly develop a National Plan for Introduction of Composite Flours calling on the resources of industry, Ministry of Agriculture, Ministry of Health, MINPLAN, MICT and others as required.

j. Arrange a seminar/workshop to disseminate to the second phase results and recommendations to the interest parties.

Phase 3

The implementation of the National Plan for Introduction of Composite Flours will be the result of the previous two phases. In this phase, it is necessary to have active participation of public and private institutions. The areas and responsibilities necessary for success of the Plan must be specified. The Plan should contain all the actions necessary for the introduction of the composite flours in the National market. Some of these actions are detailed as follows:

a. Planting of sufficient soy, rice and quinoa to meet the new demands for composite flours.

b. Installation of the necessary equipment for the production of defatted soy flour suitable for human consumption.

c. Construction of a suitable plant to produce food grade rice flours or alternatively, to provide food grade rice of suitable physical characteristics to be used directly at the flour mills.

d. Utilization of the quinoa flour expected from the Ferrari Ghezzi plant currently under construction near Oruro.

e. Installation at each of the commercial wheat mills of appropriate storage capacity of soy, rice and quinoa flours and the installation of handling and blending capacity to add the soy, rice and quinoa and other additives in the wheat flour.

f. Development and preparation by MICT of a mechanism (possibly seminar/workshops) to assist bakers and pasta manufacturers adopt the new composite flour.

g. Development by MICT of a mechanism of composite flour regulation.

h. Development by MICT of a mechanism for the purchase and import of wheats of suitable quality for composite flours.

i. Development of a plan for public promotion and information dissemination on the composite flour program and the arrangement for its execution.

Soy Flour Fortified Pasta. A Selected Review of Literature for the Bolivian Wheat Fortification Project

D. A. Fellers, June 10, 1979

General Background

The current U.S. Standards of Identity for macaroni and noodle products (1) provides for a series of pasta products from 100% semolina pasta to those containing egg white, eggs, milk, nonfat dry milk, wheat germ, gluten, soy and other protein and vegetable materials. Generally, these Standard of Identity products fall into two categories with respect to the amount of protein additives: 1. Products that contain up to 4 or 5% of protein additives (egg white, eggs, milk, gluten, wheat germ); 2. Products that contain over 10% protein additive (soy, nonfat dry milk, yeast protein and others often in combination). U.S. Standards do not exist for pastas containing intermediate levels (5 to 10%) of protein additives. This has resulted in product research and development being concentrated on products of higher protein content than that of interest for the Bolivian Wheat Fortification Project. Since 1960, there has been several studies (2-11) on high protein pastas sometimes in conjunction with other cereal extenders such as corn flour or precooked corn flour. A number of acceptable products have been claimed and some are being marketed commercially or in special programs such as the School Lunch Program. The specific formulas for U.S. commercial products have not been published and thus represent proprietary information. Such products may well contain improvers such as monoglycerides to reduce stickiness and cooking loss.

Questions About Pasta for the Bolivian Project

1. What is the suitability of soy flour at the 4 to 8% level for pasta made from hard or semi-hard bread wheat?

2. What PDI or NSI for soy flour is best for pasta when used at the 4 to 8% level and using hard or semi-hard bread wheats?

3. What is the compatibility of 4 to 8% soy flour in pasta made with hard or semi-hard bread wheats extended with 10% rice, or 10% quinoa, or 10% raw corn, or 10% precooked corn flour?

Some Pertinent Literature for the Bolivian Wheat Fortification Project

The Code of Federal Regulations (1) specifies that the soy flour used in Standard of Identity soy-fortified pastas be made from "heat-processed, dehulled soybeans, with or without the removal of fat therefrom". In Bolivia, a decision must be made as to modification of the soy plant (SAO or FACSA) to produce edible soy flour. Front-end dehulling is desired for maximum quality soy flour since this type of dehulling as opposed to tail-end dehulling results in reduced insect and hull fragments, reduced bitterness, reduced microbiological load and lighter color. It is for these reasons that the U.S. Code of Federal Regulations specifies fron-end dehulling for preparation of edible soy flour for use in pastas.

Matsuo et al (12) found improvement in cooking quality with the use of egg albumin, glutenin and higher protein durum semolinas. Spaghetti was firmer, less compressible and more elastic. The use of 3% soy flour (PDI/NSI not specified; 52% protein) had a neutral effect on cooking quality while 5% soy flour had a slight firming effect (tenderness index favorably decreased from 54 for the control semolina to 51 for the soy-fortified); compressibility favorably decreased from 80 to 72; and recovery (elasticity) was adversely affected from 17 to 14 (cooking procedure: 10g in 300 ml boiling water for 20

minutes, drain, cool in 20°C water for 10 minutes, drain, measure firmness, etc., of individual strains on Instron).

Haber et al (4) studied addition of soy isolates, a soy concentrate and a toasted soy flour at the 10% level in durum semolina and farinas from HRS and SRW.

Results with 10% defatted, toasted soy flour:

	Total Protein, %	Spaghetti Color 1/	Cooked Weight,	Cooking loss, %	Firmness,2/ g.cm.
Semolina	12.2	8.5	37.7	5.6	4.8
with 10% soy	15.9	6.0	34.0	7.8	4.5
HRS Farina	13.5	5.0	33.4	4.4	5.3
with 10% soy	17.1	4.5	33.7	7.0	6.9
SRW Farina	8.6	4.5	35.8	4.8	5.0
with 10% soy	13.3	5.5	35.9	7.6	4.9

1 Higher values represent desirable bright, amber color.

2 Higher values represent firmer pasta but above 7.0 pastas are considered tough.

Haber's results with the addition of 10% toasted, defatted soy flour showed that cooking losses were increased substantially for all three types of wheat (durum, HRS and SRW). When soy flour was added to semolina, color of resulting pasta was substantially poorer but with HRS and SRW, the addition of soy flour had little effect on color. When soy flour was added to semolina, the cooked weight of spaghetti decreased substantially but with HRS and SRW, the addition of soy flour did not affect cooked weight. For durum and SRW, firmness was not affected by addition of the 10% soy flour but firmness was increased by the addition of soy flour in the HRS pasta. No flavor tests or panel work was conducted, thus there are no results on acceptability. For Bolivia, where hard

and semi-hard wheats are used for pastas, it appears the major disadvantage of adding soy flour would be an increased cooking losses (4 to 5% for 100% wheat spaghetti and 7 to 8% for spaghetti fortified with 10% defatted, toasted soy flour).

Breen et al (5) added about 7.7, 14.6 and 21.5% of soy flour (defatted and defatted-toasted) to semolina (durum). Six different defatted and two different defatted-toasted soy flours were tested.

Results: All values are presented as a percent of the semolina control.

Product tested	Color[1]	Cooked Wt.[2]	Cooking loss[3]	Firmness[2]	Taste panel[4]
		-soy flour addition at 7.7% level			
Ave. of 6 defatted soy flours	98.2	96.4	130.8	106.0	86.6
Ave of 2 defatted-toasted soy flours	94.1	96.2	112.4	109.7	87.8
		-soy flour addition at 14.6% level			
Ave. of 6 defatted soy flours	93.3	93.6	144.6	107.0	79.2
Ave. of 2 defatted-toasted soy flours	84.9	91.6	124.6	107.7	71.2

1 Acceptable equals greater than 80.

2 Acceptable equals greater than 90.

3 Acceptable equals less than 140.

4 Acceptable equals greater than 50; value includes specific evaluation of texture and flavor.

These results indicate good acceptability for 7.7% soy whether the soy flour is toasted or not. At the 14.6% soy level, acceptability might be described as fair. Toasted soy flour caused more color deterioration but results in reduced cooking loss compared to lightly heated soy flours. It is likely that soy flours moderately heated (NSI of 25-45) would represent the optimum soy flour for

fortification of semolina. However, when farinas (hard bread wheats) are used instead of durum semolina, it is likely that the toasted soy flour would not have as detrimental an effect on color (4) but would still provide the lower cooking loss effect. Thus, there may be a slight advantage for the toasted soy flour when using farina for pasta production. In Bolivia, there is a substantial capital investment advantage to toasted soy flour, that is, the desolventizer-toaster systems already in place in Bolivia's two modern solvent extraction plants would not have to be replaced or modified. This savings would be on the order of $300,000 to $500,000 for the soy plant to be modified to produce edible soy flour. Another advantage of toasted soy flour is the assured destruction of trypsin inhibitor, whereas because of the low 87°C boiling point (La Paz), destruction of active trypsin inhibitor in pasta during cooking may be questionable.

Paulsen (8) studied the addition of 12.5, 17 and 25% addition of Ardex 550 soy flour to semolina. His results point out that cooked weight, cooking losses, and firmness are related to cooking time (0 to 90 minutes) and also to the diameter of spaghetti. Inclusion of Ardex 550 or increased spaghetti diameter (0.065 to 0.075 in.) reduced the water absorption rate on cooking and increased firmness at any given cooking time. Ardex 550 caused increased cooking losses (at 20 minutes of cooking, 100% semolina pasta had 5.4% cooking loss while 12.5% Ardex pasta had a 7.5% cooking loss. Paulsen points out that soy flours have 35% soluble carbohydrates and presumably these contribute to cooking losses in soy flour fortified pastas.

Leitao et al (13) reported that SSL (sodium stearoyl-2-lactyllactate) improved the physical appearance and body of macaroni fortified with up to 20% of soy flour.

Pasta doughs for extrusion are typically about 31% moisture. Walsh et al (13) have reported that moisture content at extrusion along with other factors such as extrusion temperature (less than 150°F.) and extrusion rate does affect pasta quality. Researchers working on soy fortified pastas have not reported on this aspect. Breen et al (5), who studied the addition of 7.7 to 21.6% soy flours, reported doughs were made to 31% moisture but that "some variation was used when necessary to assure processing". The relative inattention to extrusion moisture suggests little change from standard procedures as a result of soy fortification. The same conclusion might be drawn about drying of soy-fortified pasta which has also been neglected in the literature.

Storage stability of soy flour fortified pastas has not been reported in the literature, though the acceptance of soy-fortified pastas in the U.S. School Lunch Program suggests reasonable stability. Other cereal-soy blends have demonstrated stability.

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FORTIFIED PASTA: RESEARCH NEEDS FOR BOLIVIA

1. Suitability of 4 to 8% soy flour for pasta. It appears that pasta with good acceptability can be prepared using 4 to 8% soy flour. Because bread wheats are used in Bolivia instead of durum, little or no color deterioration would be expected. This assumes that soy flour would be produced from front-end dehulled soybeans. Such pastas can be expected to have higher cooking losses than 100% wheat pasta. At high altitudes, the addition of soy flour may increase the cooking time. This is indicated by the suggestion of several workers that soy flour results in a reduced rate of water absorption during cooking and firmer pasta. At La Paz, the cooking temperature of pasta would be only 88°C (boiling water). At Potosi which is 14,000 feet, cooking temperature is even less at 85°C.

Needs:

a. In the laboratory, determine the effect of reduced cooking temperature on soy fortified pasta. If vitamins and minerals are added, determine effect on quality.

b. In a commercial pasta plant, demonstrate production of soy fortified pasta.

c. Determine consumer acceptability of commercially produced soy-fortified pasta.

2. What PDI or NSI soy flour should be used? The literature evidence appears to give a slight advantage to fully toasted soy flour. Because equipment to produce toasted, defatted soy is already installed in Bolivia, this is additional support in favor of deciding on toasted soy flour for use in pastas. Assured destruction of trypsin inhibitor is a further argument for selection of toasted soy flour.

3. Suitability of 4 to 8% soy flour with 10% extenders. The literature searched did not provide any specific information on the quality of pastas prepared with 4 to 8% soy extended with 10% rice, or quinoa, or corn, or precooked corn flours.

Needs:

a. In the laboratory, evaluate pastas produced with 4 to 8% toasted defatted soy flour and 10% rice, or 10% quinoa or 10% corn, or 10% precooked corn flour. Evaluate stability. If vitamins and minerals added, test effect on quality.

b. In a commercial pasta plant, demonstrate production of pastas described in 3.a.

c. Evaluate products of 3.b. in consumer acceptance tests that include home cooking.

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Appendix B-6

REPORT ON THE NATIONAL PRODUCTION OF SOYBEANS AND ITS INDUSTRIALIZATION

JUNE 1978

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Project: "Improvement of the Nutritional Value of Foods Based on Wheat Flour"

SUMMARY

Soy is processed principally for the production of oil; the cakes or flours which are obtained as byproducts are intended as animal feed. There is no production of soy flour for human consumption, firstly because no demand exists and secondly because the existing factories don't have the equipment necessary for its production.

OIL INDUSTRY

The national oil industry started approximately in 1968 with the operation of Industrias de Aceite S.A. (Oil Industries, S.A.) Thereafter Industries Oleanginosas Ltda. (Oil Industries Limited) and Compania Oleanginosa Ltda. (Oil Company Limited) entered into operation. These three private factories established themselves through considerable effort on the part of their owners; their development was slow and their production rhythm irregular and inadequate to meet the internal demand for edible oils.

At the beginning of 1972 plans were made for the implementation of new oil production plants; to date 4 plants have been installed. Among these, two have the function of integrating the expelling process for the extraction of their oil. The other two plants which have been installed are: Sociedad Aceitera del Oriente (Eastern Oil Society) (S.A.O.) and Fabrica de Aceitas de Villamontes of the Corporacion Boliviana de Fomento. The first of these entered a trial period in the middle of 1976 and the second in October of 1977; both have large production capacity and use modern technology including solvent extraction.

Among the plans for the installation of oil production plants, are those of the Bolivian Vegetable Oil Society S.A. During 1975, the project advanced somewhat in its construction of buildings and its acquisition of equipment and machinery, but then these activities came to a stand still. In January of the present year one of the Societies' members reported that before carrying out the project mentioned above, they were planning the financing for its total implementation.

The situation of this industrial group is shown in Table No. 1.

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TABLE NO. 1

COMPANIES IN THIS SECTOR (1978)

COMPANY	PRESENT SITUATION AND PRODUCT	LOCATION OF OPERATION
Industrias de Aceite S.A.	In production - refined oil (edible)	Extraction: Santa Cruz Refining: Cochabamba
Industrias Oleaginosas Ltda.	In production - edible oil.	Extraction and Refining: Santa Cruz
Compania Oleaginosa Ltda.	In production - edible oil.	Extraction and Refining: Santa Cruz
Cooperative Integral Guabira	At a standstill (paralized)-crude oil.	Extraction: Santa Cruz
Complejo Industrial Godefroid (Industrial Complex)	In production - crude oil	Extraction: Santa Cruz
Sociedad Aceitera del Oriente	In production - edible oil (by solvent)	Extraction and Refining: Santa Cruz
Fabrica de Aceites (Oils Factory) S.A.	Adjustments and trial runs in the extraction (by solvent) plant - Edible oil.	Extraction and Refining: Villamontes

SOURCE: "Diagnostic of the National Edible Oils Industry"--D.G.N.T.-April 1978.

RAW MATERIAL

The raw material, which is traditionally processed by the national vegetable oil industry, is cottonseed and soy. Besides these, crude oil is imported as a result of insufficient domestic raw material.

AREAS IN CULTIVATION

Bolivia's prospects for the cultivation of soybean are excellent, considering her readily available agricultural potential along with ecologically adequate regions for soy production.

The cultivation areas are: The Department of Santa Cruz, center of major production, where 90% of the total area cultivated is found, and the Department of Tarija in the region of Yacuiba and Villamontes, and the Department of Cochahamba in the Chapare Tropical region.

VARIETIES CULTIVATED

The commercial varieties which are destined for the oil factories are:

Variety	Region
Pelicano	Santa Cruz
Santa Rosa	Santa Cruz (especially in Yapacani.)
Halosoy and Pelicano	Tarija

On a regional basis within the Proyecto de Oleaginosas (oil project) "Gran Chaco," attempts have been made toward the introduction of the variety Bossier which, according to information obtained, has given very good results in terms of per hectare yield.

PLANTING PERIOD

Summer is considered the optimum cultivation period; the optimum planting time fluctuates between the 15th of November and the 15th of January, depending on the length of the vegetative stage of the variety planted. The winter planting is done in the months of April and May and produces a small quantity of grain and is done only with the intention of obtaining seeds for the large summer plantings.

YIELDS

The yield of soybeans per unit of area is variable, depending on the favorability of the weather; in the area of Santa Cruz the yield fluctuates between 1,700 and 2,000 kg. per hectare; around Chaco yields of 1,600 to 1,800 kg per hectare are being obtained.

HARVESTING SYSTEMS

In Santa Cruz the cultivation of soybeans is mechanized. A copy of production costs for soy in Tariza is attached.

CULTIVATED AREAS AND FUTURE AREAS OF CULTIVATION

The cultivation of soybeans is recent (1973) from the commercial point of view or large scale production; the increase in the cultivation of this grain is due mainly to the policy of establishing new oil producing plants in the country. In Table No. 2 the production and cultivation history of soy is shown.

TABLE 2
HISTORY OF THE CULTIVATION AND PRODUCTION OF SOYBEANS

Year	Hectares	Yield kg/ha	Production TM
1969/70	1,000	1,500	1,500
1970/71	800	1,500	1,200
1971/72	800	1,500	1,200
1972/73	2,000	1,700	3,400
1973/74	5,800	1,380	8,004
1974/75	9,450	1,266	11,930
1975/76	12,100	1,270	15,370
1976/77	7,300[o]	1,200[o]	8,855[o]
1977/78	22,000[oo]	1,200[oo]	26,400[oo]

Source: Agricultural Statistics -- Minister of Farm and Agricultural Affairs-
1976 - 1977:[o] Provisional Data,[oo] Estimated.

PRODUCTION COSTS

CROP Soy VARIETY Pelicano PER Hectare

OWNERSHIP Agricola "CANADA ANCHA" YEAR 1977

CANTON Saladillo PROVINCIA Gran Chaco DEPT Tarija

Date Carried Out	Operation	Unit $b[1]	Total $ b[1]	
	Soil Preparation			
Nov. 10, 1976	machine plowing	350.-	350.-	
Dec. 8, 1976	first leveling	200.-	200.-	
Jan. 9, 1977	second leveling	200.-	200.-	
Jan 9, 1977	ant control with (glacoxan)		100.-	
	Planting			
Jan. 10, 1976	60 kg seeds	7.5	450.-	
Jan. 10, 1976	250 grams of innoculant	25.-	25.-	
Jan. 10, 1976	machine seeding	200.-	200.-	
	one laborer for seeding	40.-	40.-	
	Cultural Operations			
Feb. 12, 1976	12 man-days for 1st weeding	40.-	480.-	
Feb. 15, 1976	500 c.c. of Metasystox	200.-	100.-	
Feb. 15, 1976	Dusting with motorized sprayer	200.-	200.-	
Feb. 15, 1976	One worker to handle insecticide	40.-	40.-	
March 16, 1976	8 man-days for 2nd weeding	40.-	320.-	
April 14, 1976	4 man-days for chopping	40.-	160.-	
	Harvesting			
May 10, 1976	Thrashing of 1,500 kgs (estimation)	0.5	750.-	
May 10, 1976	6 sacks	15.-	90.-	
May 10, 1976	Internal transport	0.1	150.-	
May 10, 1976	4 man-days for harvesting	40.-	160.-	
June 10, 1976	Transport to Villamontes of 1,500 Ks.	0.2	300.-	
	Total Direct Expenditures	4,315.-	4,315.-	4,315.-
	10% interest on circulating capital	431.-	431.-	431.-
	10% reserve capital		431.-	
	% Amortization on fixed investments		165.-	
	Total indirect expenditures		1,027.-	431.-
	Total expenditures or costs		5,342.-	4,746.-
	Total earnings from 1,500 kgs. of production $b. 4.- c/u.		6,000.-	6,000.-
	Total Cost		5,342.-	4,746.-
	Net Profit:		658.-	1,254.-

1. $US 1.00 = $b 20

According to the National Plan for Social and Economic Development (1976-1980) the projected cultivation of soybeans in the period of 1978 - 1980 is shown in Table No. 3.

TABLE NO. 3
PROJECTED AREA FOR THE PRODUCTION OF SOYBEANS

Year	Hectares	Yield kg/ha	Production TM
1978/79	50,389	1,290	65,002
1979/80	68,025	1,296	88,160
1980/81	91,833	1,300	119,383

Source: National Plan for Economic and Social Development - Volume II

By Resolution 13915, dated August 30, 1976, the Oil Project "Gran Chaco" was created under the direction of the Ministry of Farm and Agricultural Affairs (MACA) with the purpose of promoting, extending and directing the production, destined to cover the demand required for the Oil Factory of Villamontes.

From the information obtained from the Bolivian Institute of Agricultural Technology (IBTA) it is known that in order to cover the requirements of the oil factory (FACSA) approximatelyu 54,101 hectares planted with oil crops and corn or other grains is needed, in order to be able to rotate the crops tentatively in the following manner:

Peanuts	17,101	1,5 TM/ha	25,651
Soy	10,000 ha	1,5 TM/ha	15,000
Cotton	5,000 ha	1,5 TM/ha	7,500

The Project Gran Chaco has 1,161 cultivated hectares of soybeans as of 1977.

DEMAND AND SUPPLY

The demand for soybeans during the period 1974-1977 is shown in Table 4.

TABLE 4
CONSUMPTION OF SOY

Year°	Soy TM
1974	3,900
1975	4,100
1976	3,130
1977	8,050

Source: Diagnostic of the National Edible Oils Industry. D.G.N.T. - April 1978
°Information corresponding to 3 factories

During 1977 SAO processed 5,000 TM of soy, Industrias de Aceita S.A., 2,050 TM and Industrias Oleaginosas LTDa., 1,000 TM.

According to information supplied by the engineer Jorge Taborga, SAO will need, for the coming year, 7,000 TM of soy, FACSA up to the end of May (1978) received about 9,000 TM of soy from Santa Cruz, El Chaco and a small amount from Argentina; all of which indicates that both plants will process about 16,000 TM of soy, which according to the production estimated for this year, would leave a surplus to be processed by the rest of the factories.

The supply of soy grain for 1978 will be 26,400 TM and for 1979 and 1980 it will reach 65,002 and 88,160 TM resepctively. Concerning the object of the project "Improvement of the Nutritional Value of Foods based on Wheat Flour," for the demand for soy of the oil factories, SAO and FACSA of Villamontes, see Table No. 5.

TABLE NO. 5
DEMAND FOR SOY

FACTORY	CAPACITY TM/DAY	SOY TM/250 day year
Sociedad Aceitera del Oriente (Eastern Oil Society)	200	50,000
Fabrica de Aceitas S.A. (Oil Factory)	300	75,000

As can been seen in the above table, the demand for soy for the two oil factories reaches a total of 125,000 TM for the year, working at full capacity, which in terms of the supply which is to be available in 1979 and 1980 results in a production deficit.

SOY MARKET

The soy market is centralized in the region of Santa Cruz where 71% of the oil producing factories are found.

USES OF SOY

Almost 100% of the soy produced is intended for use in the edible oil industries and to a very limited extent for use in the productionn of protein rich foods such as MAISOY, in which soy is used as a compliment to corn; also it is employed in the preparation of some dishes.

In Cochabamba, Sr. N. Guzman stated that during 1977 the production of whole soy flour was initiated; the problem which he encountered was the lack of a market for this flour owing to the lack of general knowledge about the nutritive value of soy and its uses. He also said that the University of North Carolina has offered him technical assistance as well as financial help so that he can continue with this production.

MARKETING

The marketing of soy is often carried out through intermediates who collect from farmers and then sell to oil processors. Such is the case of CEIBO which provides oil seeds collected in Santa Cruz to FACSA in Villamontes. Farmers also sell directly to oilseed processors.

COMPOSITION OF SOY

The composition of the soy produced domestically is shown in Table No. 6.

TABLE NO. 6

Region Composition	Area of Production Santa Cruz	 Tarija
Oil %	21.19	20.59
Protein Nx6.25 %	40.78	38.85
Crude Fiber %	11.50	12.88

The samples are from the 1978 harvest and were furnished by the Fabrica de Aceites of Villamontes

TECHNOLOGICAL ASPECT

FABRICA DE ACEITA S.A. * CBF

The Fabrica de Aceites of Villamontes presently is in a period of adjustment and testing of the cleaning equipment, as well as the preparation and oil extraction machinery which has a capacity of 300 TM per day. As with SAO it hasn't got the necessary equipment for the production of soy flour for human consumption.

The Corporacion Boliviana de Fomento looked for the provision of its oil plant at Villamontes under the "Key in Hand" system; the foreign company which conceded this contract is De Smeth, of Argentinan-Belgian origin, from who, at the same time, the Bolivian corporation is receiving technical assistance.

This plant is versatile, it can process cottonseed, soy, and peanuts. The process which is used in the manufacture of soybean oil is indicated in graph No. 1.

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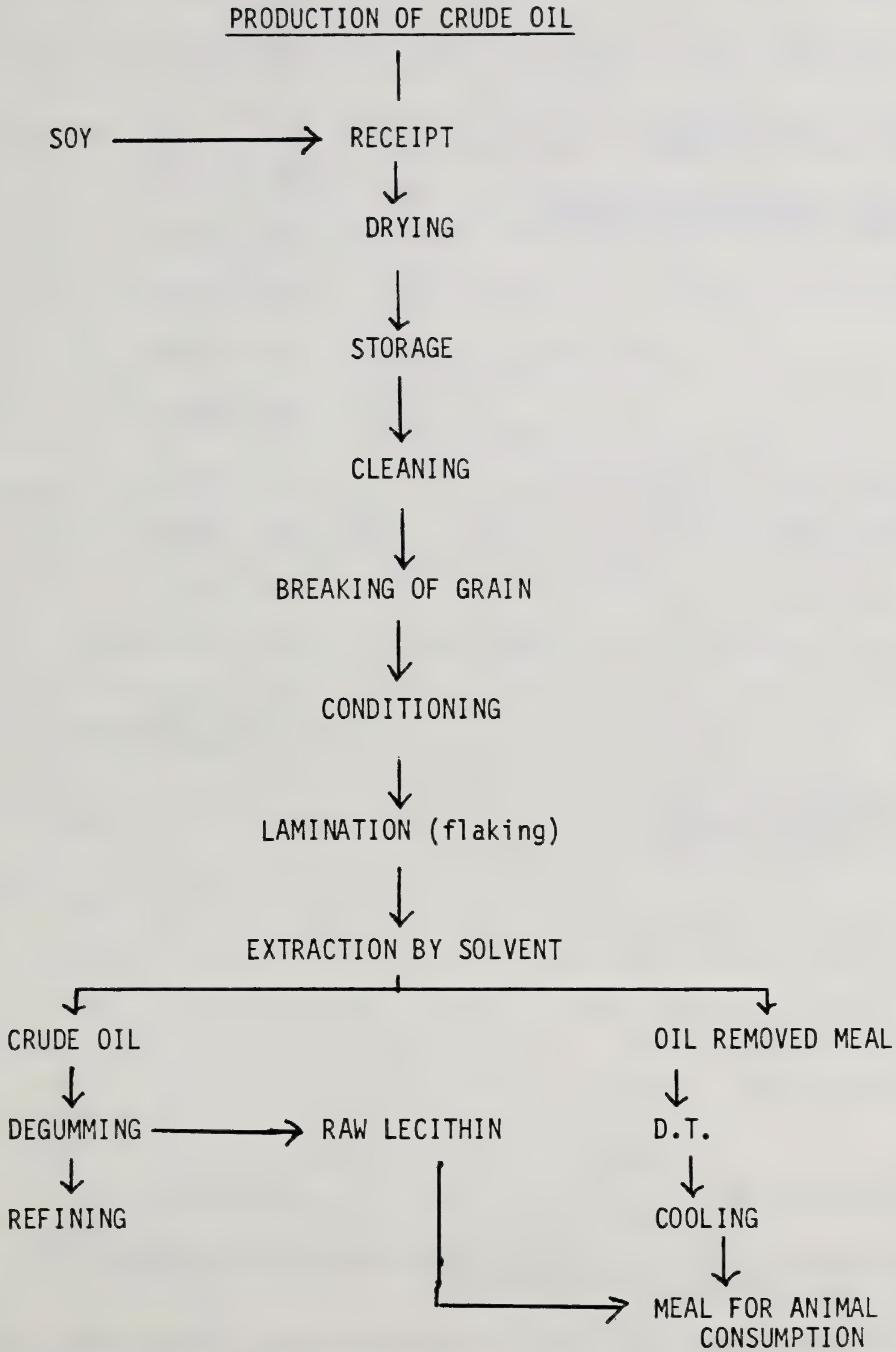
GRAPH No. 1



The equipment available to FACSA is as follows:

1. RECEPTION OF SEEDS:	
1.1 Scale	N.A.
1.2 Dryer Cap.	300 TM/day
1.3 Silos: Muskogee for cottonseed	20,000 TM
concrete verticals (soy)	40,000 TM
2. CLEANING AND PREPARATION OF THE SEEDS	
2.1 Seed Cleaners (3)	300 MT/day
2.2 Roller mills	300 TM/day
2.3 Cookers (2)	300 TM/day
2.4 Laminators (2)	300 TM/day
2.5 Dehusker and separaters (cottonseed)	200 TM/day
2.6 Beaters for cottonseed	200 TM/day
2.7 Expeller (for cottonseed) (3)	150 TM/day
3. EXTRACTION BY SOLVENT	
3.1 For soy	300 TM/day
For cottonseed	150 TM/day
4. TREATMENT OF THE DRAINED FLOUR	
4.1 Solvent remover-toaster (D.T.)	
4.2 Cooler	
5. STORAGE OF THE FLOUR	
5.1 Silos (3)	N.A.
5.2 Packager and bag stitcher	N.A.
6. REFINING	
6.1 Refining of the crude oil	65 TM/day

This equipment and machinery which is used by FACSA has been manufactured in various countries: U.S., Belgium and Argentina.

According to the information given by one of the technicians from De Smeth, the D.T. which FACSA uses is not adequate for the production of soy flour intended for human consumption because of the heat treatment which reduces the nutritional value of the flour and the dispersability of the protein in water and causes darker color and off flavor.

EASTERN OIL SOCIETY

This oil plant was also installed under the "Key in Hand" system; the firm in charge was the Industrial Engineer Co. of Israel.

It is a versatile plant where presently cottonseed and soy are processed. For soybean oil production, the process used is as follows:

(a) Cleaning of the grain, where all the impurities are eliminated but not the damaged, split or bicolored kernels.
(b) Breaking of the grain by which means the size of the particles are reduced, leaving the husk free but not separating it from the pulp or flesh of the seed.
(c) Conditioning and flaking the kernels.
(d) Extraction by solvent of the oil contained in the flakes; the flour comes out of the extractor containing 0.5% oil.
(e) Eliminating the gumminess of the crude oil obtained.
(f) Taking the solvent out of the de-greased meal, this is done through a steam treatment at 100° centigrade in a D.T.
(g) Bagging or pelleting the solvent-removed meal to which crude lecithin is added.

Graph No. 1 shows this process; the meal or pellets obtained by this process are intended as animal feed. Attached is a copy of the laboratory analysis of this type of flour processed in the SAO plant and analyzed in the laboratories of the DGNT.

DETERMINING THE SIZE OF THE PARTICLES IN SOY MEAL

Sieves, Mesh No.	Percent	Make-up
45	27.71	husk, thick soy and foreign matter
50	10.14	husk, thick soy and foreign matter
60	10.86	husk, thick soy and foreign matter
100	22.53	flour
120	17.20	flour
Base Pan	11.56	flour

The equipment and machinery used by this oil plant is manufactured in Germany, The U.S. and Brazil. This machinery is described below:

1. RECEPTION AND STORAGE OF THE SEEDS

1.1	Scale	Adequate
1.2	Dryers for seeds (3 Goldsaats)	600 TM/day
1.3	Silos (2 Muskogee)	40,000 TM/day

2. CLEANING

2.1	Cleaner (1)	200 TM/day
2.2	Medium cleaners (3)	600 TM/day
2.3	Dehuskers for cottonseeds (4)	160 TM/day

3. PREPARATION

3.1	Breaker (1)	200 TM/day
3.2	Flakers (2)	200 TM/day
3.3	Cookers (3)	240 TM/day

4. EXTRACTION

4.1	Expeller for cottonseed (3)	240 TM/day
4.2	By solvent:	
4.2.1	Continuous extractor for soy	200 TM/day
4.2.2	Continuous extractor for cottonseed	150 TM/day

5. TREATMENT OF THE DEFATTED FLOUR

5.1	Solvent remover-toaster (DT)	200 TM/day
5.2	Hammer Mill (1)	6 TM/hour
5.3	Pellitizer (1)	5.2 TM/hour

6. STORAGE

6.1	Silos for flour	N.A.

7. REFINING

7.1	Refinery	40 TM/day

PRODUCTION OF SOY FLOUR FOR HUMAN CONSUMPTION

As has already been mentioned the production of soy flour for human consumption is non-existent; there is no demand for this flour and the national industry does not have the appropriate machinery and equipment for this production.

Within the Project "Improvement of the Nutritioonal Value of Foods Based on Wheat Flour" SAO and FACSA are being considered as possible production plants of soy flour for human consumption, owing to the fact that the process which they employ, and the equipment and machinery which they use lend themselves more toward this type of production. Nevertheless both plants would have to increase some of their operations in the current process, as well as obtain equipment which they presently lack.

The operations which should be augmented are the following:

(a) Elimination of all the parted or split, damaged, and bicolored grains and foreign matter which affect the ultimate quality of the soy flour.
(b) Separation of the husks from the pulp.
(c) Milling and fine sifting of the flour from which the solvent has been removed.

In order to obtain these goals the equipment which must be obtained for each one of the factories is as follows: FACSA: flash type desolventizer in order to obtain a flour with a maximum NSI. Hammer mill for the milling of the flour after removal of the solvent, made in such a way that 97% passes through the No. 100 U.S. Standard Screen. SAO: Vibrating sifters with a vacuuming system with air where the husks are separated from the pulp. Flash type desolventizer. Hammer mill and sifters.

The production of soy flour for human consumptiopn and animal consumption has been calculated according to the following balance of material:

FACSA: Processing capacity 300 TM/day
Days worked: 250 day a year.

Material which enters:

300 x 0.20 = 60 TM of crude oil
300 x 0.80 = 240 TM of meal

Material which leaves (the plant):

Consider: 0.5% of oil in defatted meal
2.5% gums

$240 \times \frac{0.5}{95} = 1.26$ TM of oil in meal

$60 \times \frac{2.5}{97.5} = 1.5$ TM of gums in raw oil

240 + 1.26 + 1.5 = 242.76 TM of meal for animal feed.

The production of soy flour for human consumption will be of 222 TM per day, having in mind that 7% is husks which are eliminated and that the raw lecithin is not counted. The annual production of these flours is:

Soy Flour for animal consumption: 243 x 250 = 60,750 TM
Soy Flour for human consumption: 222 x 250 = 55,500 TM

Soy Flour for human consumption: 222 x 250 = 55,500 TM

SAO: Capacity - 200 TM/day
days worked: 250 days a year

Production: (Under the same conditions described for FACSA)

Soy flour for animal consumption: 162 x 250 = 40,500 TM
Soy flour for human consumption: 147 x 250 = 36,750 TM

NECESSARY INVESTMENT IN ORDER TO OBTAIN THE EQUIPMENT

According to the information provided (January - 1978) by engineers Otero and Taborga of the SAO factory, the equipment necessary to obtain for the production of soy flour intended for human consumption would require an investment of $500,000 in U.S. currency, which could be made available to them if the government could assure them of a stable market.

According to the information obtained from the CBF, through Engineer Dehasa, the investment which they could make to obtain their equipment also will be subject to the demand for soy flour and to the authorization which could be given by the Minister of Industry, Commerce and Tourism (MICT) for the use of soy flour in the making of bread.

To summarize, presently neither of the two companies have plans to enter into the production of this flour, on the contrary they have plans for the production of vegetable shortenings.

THE PRICE OF SOY

The marketing of the soy is subject to bonuses or penalties depending on its greater or lesser degree of quality. SAO carries out its selling and buying contracts based on American standards and offers the farmer a price of $US 215; FACSA on the other hand uses Bolivian standards in its buying selling activities; the price of the metric ton of soy set by Villamontes, according to the information given by Engineer Zamora, manager of that factory, is $US 267.50, which includes the transportion fees from Santa Cruz to Villamontes and the commission to CEIBO. In Annex No. 1 the quality of domestic soy received by FACSA is shown.

SOLVENT

The solvent which is used is produced nationally and costs $0.26 US dollars per liter; fixed price Santa Cruz; previously hexane was imported from Argentina at a price of $.40 US dollars per liter.

From information provided by FACSA it is known that the characteristics of the solvent SAM are the following:

Specific gravity: 60/60° C	0.680
Distillation 760 mm Hg.	90% to 170°F Max

DEMAND OF SOY FLOUR FOR HUMAN CONSUMPTION

It is estimated that consumption of wheat flour for 1978 will be 194,641 TM;

The demand for soy flour for the same year is estimated on a basis of two alternatives: 1st alternative: 6% substitution - 11,679 TM
2nd alternative: 8% substitution - 15,571 TM

THE PRICE OF SOY FLOUR

To estimate the price of soy flour intended for human consumption, the production of soy flour for animal feed, which is 162 TM/day, has been taken as a basis; the price of this quantity reaches $810,000 in Bolivian currency, but in the production of soy flour for human food the husk is eliminated, thus lowering production to 147 TM/day; it has been considered that the producer would have to obtain the same sales value (810,000 Bolivian pesos) for these 147 TM, from which we can determine a price of 5,500 Bolivian pesos/TM ($US 275/TM.)

On the other hand the relation which exists between the price of the soy in kernel, 4,350 $b/TM, and that of the flour for animal feed, which is 5,000 $b/TM has been considered. From which:

$$\frac{5000}{4.350} = 1.15$$

$$5.5 \times 1.15 = 6.3 \text{ \$b/kg}$$
$$6{,}300 \text{ \$b/TM}$$

The price of a quintal (46 kg) plus the packaging (15 $b), is estimated at 305 $b.

CONCLUSIONS

According to the information obtained neither SAO nor CBF have plans to enter into the production of soy flour for human consumption, their main reason being the lack of a market for this product.

SAO, because of the importance which they attach to the Project "Improvement of the Nutritional Value of Foods Based on Wheat Flour," and because of its interest in being able to enter into this field of production, has informed itself regarding the required investment for obtaining the necessary equipment, which would in fact cost $500,000 US dollars.

Both SAO and CBF intend to enter into the production of soy flour when and if the government authorizes its consumption on a national level.

The installed capacity of the two factories SAO and FACSA exceed the estimated demand for edible soy flour, which is 15,571 TM/year.

SAO working with 43% of its full capacity in order to process soy, could cover the demand for this soy flour (63 TM/day x 250 = 15,750 TM/year) and FACSA could do the same using 30% of its full capacity.

The raw material required by SAO in order to cover this demand is 21,500 TM/year and FACSA would require 22,500. According to the National Plan for Economic and Social Development, during the year 1978, 50,389 hectares will be planted

giving a production of 65,000 TM of soy in 1979.

Owing to the lack of experience in the production of soy flour for human consumption, it is necessary to lend all of the technical help to the company which enters into this field of production, both with respect to quality of the domestic soy and to final product, engineering of the process and production costs.

Analyzing the locations of the SAO and FACSA plants in relation to the centers of soy production and centers of consumption, means of transportation and other factors which will effect the costs of production, it is thought that SAO is the more probable plant to enter into the production of soy flour for human consumption.

ANALYTICAL DATA FROM OIL FACTORY IN VILLAMONTES
RECEPTION OF SOY SEED
HARVEST 1978

		ANALYSIS						
Date	Source	Imp:	Splits	Bicolor %	Damaged %	Humidity %	Oil %	Acidity %
03/04	Santa Cruz	5,68	9,58	0,40	3,75	11,65	20,33	0,79
03/04	Santa Cruz	2,87	6,56	0,29	2,52	11,62	20,00	0,82
10/04	Santa Cruz	5,04	4,84	0,21	1,21	9,95	20,65	0,71
11/04	Santa Cruz	2,44	15,15	0,22	3,26	11,02	20,39	0,85
12/04	Santa Cruz	1,49	5,00	0,35	0,70	11,25	20,16	0,77
13/04	Santa Cruz	3,22	6,39	1,02	1,18	9,18	20,19	0,70
17/04	Santa Cruz	4,44	5,46	0,44	0,71	-	19,76	0,70
18/04	Santa Cruz	2,14	4,06	0,12	0,51	-	19,49	0,60
19/04	Santa Cruz	1,41	6,62	1,16	1,42	14,8	19,99	0,59
20/04	Santa Cruz	2,33	3,68	0,77	2,87	9,33	19,96	0,50
21/04	Santa Cruz	1,02	3,85	1,14	1,64	8,87	19,83	0,62
22/04	Santa Cruz	1,16	3,77	0,32	2,75	9,68	19,81	0,67
23/04	Santa Cruz	1,81	5,15	1,22	1,93	9,30	20,13	0,68
24/04	Santa Cruz	0,41	9,24	0,32	2,18	9,61	20,83	0,52
25/04	Santa Cruz	1,14	3,93	2,23	5,23	10,61	20,20	0,69
26/04	Santa Cruz	0,51	5,31	1,64	2,62	9,88	20,30	0,61
27/04	Santa Cruz	0,75	5,57	0,55	2,48	9,78	20,16	0,63
28/04	Santa Cruz	0,90	3,07	1,57	3,77	9,89	20,17	0,64
29/04	Santa Cruz	0,78	3,88	1,91	3,43	9,59	20,40	0,52
30/04	Santa Cruz	0,77	3,94	3,24	3,02	10,46	20,19	0,54
02/05	Santa Cruz	0,89	5,62	1,53	1,73	9,83	20,16	0,69
02/05	Santa Cruz	0,89	5,84	2,17	2,38	9,62	20,09	0,67
02/05	Santa Cruz	1,27	11,80	2,20	3,15	9,64	20,29	0,60
Averages		1,88	6,0	1,10	2,37	10,20	20,15	0,66
15/03	Sante Fe-Argentina	0,20	0,69	-	0,24	9,00	19,06	0,88
04/04	Argentina	3,01	16,99	-	3,24	10,21	19,94	2,55
06/04	Argentina	1,00	8,67	-	3,54	10,12	19,89	2,53
24/04	Argentina	0,54	10,66	-	3,43	10,00	19,94	2,46

Appendix B-7

POTENTIAL AND COSTS FOR PRODUCING SOY FLOUR IN BOLIVIA

Contribution to the joint project--Improving The Nutritive Value of Wheat Food in Bolivia--between the Western Regional Research Center, U.S. Department of Agriculture, the Agency for International Development and the Government of Bolivia.

Albany, California 94710 April 1979

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Appendix B-7

SUMMARY

Bolivia is committed to a policy of self-sufficiency in the production of vegetable oils. Current production of oilseed crops is inadequate to satisfy the domestic demand for vegetable oils. The factors for increasing production of these crops--land, know how, financing and oilseed processing capacity--are generally favorable, but increased production is inhibited by the small domestic demand for oilseed meals.

A program to substitute 5 percent soy flour in wheat flour would help to increase the demand for soybean meal (the starting material for soy flour) and would also help Bolivia achieve other important national goals such as improved human nutrition, reduction in balance of payments, and increased domestic employment. To fortify all wheat flour with 5 percent soy flour will require about 8500 tons of soy flour. Soy flour is usually a joint product in a soybean oil extraction plant, which also produces soy meal for livestock feeding. The ratio of soy flour to soy meal cannot exceed a certain maximum without impairing the protein content of the soy meal. So as not to exceed this maximum, the production of 8500 tons of soy flour would require the processing of a minimum of 30,000 tons of soybeans and would result in 14,900 tons of soy meal. This is only slightly more than the current domestic demand for soy meal.

Since none of the existing soybean processing plants are equipped to produce soy flour, modification of one plant for this purpose would be required. The plant selected for the purpose of analyzing the costs of modfications and the costs of producing soy flour with four different systems was the SAO plant in Santa Cruz. This is one of two modern solvent extraction plants in Bolivia, either of which could be modified for making soy flour. The four systems analyzed are briefly described as flash desolventizing and desolventizing toaster systems with head end

or tail end hull removal. The criteria for selection among these systems will be the microbiological quality of the soy flour, organoleptic properties of the products in which the flour is used, and costs. There are tradeoffs among these criteria.

The estimated investment costs for modifying the SAO plant range from a high of $1,035,000 for the flash desolventizing system with head end dehulling, to a low of $435,000 for the desolventizing-toaster system with tail end dehulling. The estimated costs of soy flour, f.o.b. Santa Cruz, range from $241.77 to $221.04 per ton. The highest cost system would have the capability of producing flour of good microbiological quality and the flexibility of producing flour in a range of protein dispersibility indexes (PDI) suitable for different uses. The lowest cost system would have the capability of producing flour of satisfactory microbiological quality, but with a low PDI, therefore its use in different end products would be limited.

Also discussed are the costs of transporting soy flour to the flour mills, the costs of dough conditioners and the costs of blending these with wheat flour.

Appendix B-7

POTENTIAL AND COSTS FOR PRODUCING SOY FLOUR IN BOLIVIA[1/]

Robert V. Enochian[2/]

INTRODUCTION

The Government of Bolivia (GOB) is committed to a policy of becoming self-sufficient in the production of vegetable oils and producing an exportable surplus. Oilseed crops include soybeans, cottonseed, peanuts, and a minor production of sunflower and sesame. Current production of these crops is inadequate to satisfy the current annual domestic demand for vegetable oils estimated at about 13,000 tons.[3/]

Other goals of the GOB are to improve human nutrition, to reduce the balance of payments deficit, and to increase domestic employment opportunities. A proposal for partially accomplishing all of these objectives is to fortify and extend the wheat flour supply--most of which is produced from imported wheat--by the addition of flours made from locally grown crops such as soybeans, rice, corn, and quinoa. This paper evaluates the potential and costs of using soy flour made from locally grown soybeans for this purpose.

1/ Soy flour in this report refers to defatted soy flour suitable for human consumption as opposed to soy meal for animal feeding which, in Bolivia, is called "harina." The english translation of "harina" is "flour" which frequently leads to confusion.

2/ Enochian is an economist with the Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture, located at WRRC, Albany, CA 94710.

3/ Tons throughout this report refer to metric tons (2204.6 pounds).

BOLIVIAN SOYBEAN SITUATION AND OUTLOOK

The five-year agriculture plan (1976-80) calls for the encouragement of oilseed production, including soybeans, through research, extension, farm credit, and guaranteed price programs. According to government reports there are many areas in the country where appropriate ecologic conditions exist to support a large production of soybeans. Furthermore, around Santa Cruz and Villamontes there are large tracts of unused land that are suitable or can be made suitable for soybean production. In addition, soybeans can be grown as either a summer or a winter crop in Bolivia; therefore, can be grown the same year on the same land in rotation with another crop.

Soybeans have not been as profitable a crop to farmers as cotton. However, soybeans can be planted and harvested mechanically while cotton requires a large number of workers. Most of these workers must come from the Altiplano and are reportedly becoming more difficult to obtain for work in the hotter more humid areas where cotton and soybeans can be grown.

The first oilseed processing plant was established in Bolivia in 1968. Since that time seven additional plants, all but one of which can process soybeans, have been built. Two of the plants are of modern solvent extraction design. The total soybean processing capacity of these plants--206,500 tons[4,5]--is far in excess of that required to

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[4] When processing cottonseed the capacity is even greater.

[5] Carlos Cosio Montaño, Report on the Production, Commercialization, and Uses of Soybeans and Other Products; Cochabamba, Bolivia, Oct. 3, 1977.

satisfy the domestic demand for vegetable oils--currently estimated at about 13,000 tons, requiring about 65,000 tons of soybeans[6]--but also enough to produce a sizeable exportable surplus. At present this capacity is grossly underutilized.

Concurrent with the establishment of the first oilseed processing plant, commercial plantings of soybeans were initiated and plans were developed for expanding soybean production. Annual plantings, yields, and production of soybeans for 1969/70 through 1977/78 are given in table 1, which also gives annual projections for 1978/79 through 1980/81. These data indicate a steady growth in the production of soybeans through 1975/76, with a sharp decline in 1976/77, followed by a large increase in 1977/78. Projections for 1978/79-1980/81 are from the GOB's five-year plan and, perhaps, are not only overly ambitious, but also not based on important economic considerations. This conclusion is based on the history of soybean production in Bolivia and on the current supply and demand situation for soybeans and soy meal.

The 1976/77 drop in soybean production has been attributed to a number of factors the most reasonable of which seems to be that the demand for soy meal in Bolivia has been inadequate for soybean processors to sustain a rapid growth in its production at prices that would be profitable. Because of this situation, soybean processors could not offer farmers the guaranteed price for soybeans, who, therefore, reduced their plantings that year. The guaranteed price for soybeans, currently set at $217.50 per ton, is considered a minimum price that is profitable for efficient

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[6] Estimated by officials of Sociedad Aceitera del Oriente (SAO).

Table 1. Area planted, yield, and production of soybeans, Bolivia, 1969/70-1977/78 and projections 1978/79-1980/81.

Year	Hectares No.	Yield Kg/Ha	Production Tons
1969/70	1,000	1,500	1,500
1970/71	800	1,500	1,200
1971/72	800	1,500	1,200
1972/73	2,000	1,700	3,400
1973/74	5,800	1,380	8,004
1974/75	9,450	1,266	11,930
1975/76	12,100	1,270	15,370
1976/77 1/	7,300	1,200	8,855
1977/78 2/	22,000	1,200	26,400
1978/79 3/	50,389	1,290	65,002
1979/80 3/	68,025	1,296	88,160
1980/81 3/	91,833	1,300	119,383

1/ Provincial data.

2/ Estimated.

3/ Projected.

SOURCES: Agricultural Statistics, MACA (through 1977/78).
National Plan for Economic Development (1976-1980) Vol. II (1978/79-1980/81).

producers. Two separate estimates indicate farm production costs of about $267 per hectare.[7] At this cost, the minimum yield would have to be 1230 Kg per hectare just to break even. In the past three years, average yields have ranged from 1200 to 1270 Kg per hectare.

Other factors, such as inadequate availability of credit for growing soybeans, also might have had an effect on production in 1976/77 and may be important for achieving projected production. Nevertheless, it seems that adequate land, financing, and price incentives are not significant barriers to the increased production of soybeans in Bolivia, but rather the lack of demand for soybean meal.

The current internal demand for soybean meal is not adequate to keep the capacity of the oilseed processing industry fully utilized. Partial utilization of this capacity is achieved through the refining of imported crude vegetable oils. In 1977, 14,000 tons of crude vegetable oils were imported by the oilseed processing industry at a cost of $9.0 million. Since domestic consumption of vegetable oils that year was estimated at only about 9,500 tons,[8] a large part of this imported oil apparently was reexported after refining. Thus, while Bolivia plans and works toward the day when it will be self-sufficient in both the production of vegetable oils, as well as being an important foreign supplier, the refining of imported crude vegetable oils for both domestic and foreign markets helps Bolivia's balance of payments situation.

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[7] Carlos Casio Montaño, op. cit., and Emilina Requirin, Informe Sobre La Produccion Nacional de Soya y Su Industrializacion, MICT, La Paz, Bolivia, June 27, 1978.

[8] MACA.

Soybean producers, processors, and the GOB must all be active participants if the desired objectives of balanced growth between soybean production and processing are to be achieved and wide swings in production and prices of soybeans reduced. To help achieve these goals a national association of oil producers (ANAPO) was created in 1977. This organization participates with the government in planning production, setting guaranteed prices, negotiating sales, and encouraging research to improve soybean yields. ANAPO could be instrumental in helping develop a program for fortifying and extending wheat flour with locally produced soy flour. Important elements of such a program are the level of soy flour fortification that can realistically be achieved now and in the future, and the prices that should be charged for soy flour.

Currently the target level of soy flour fortification is 5 percent soy flour in all wheat flour produced in Bolivia. Whether or not this is a realistic level is examined and evaluated in the following section of this paper. A decision as to whether or not to have a program of soy flour fortification and the price to charge for soy flour should not be made without knowing the costs of producing soy flour. A final section of this paper provides an estimate of such costs.

POTENTIAL FOR FORTIFYING WHEAT FLOUR WITH 5 PERCENT SOY FLOUR

Current production of wheat flour in Bolivia is estimated to be 170,000 tons. To achieve the desired objective of fortifying all wheat flour with 5 percent soy flour will, initially, require an estimated 8,500 tons of soy flour.

In the manufacture of soy flour, important joint products are soy oil and soy meal for livestock feed. The production of soy meal by a manufacturer of soy flour provides a means of economically utilizing the broken, split, and other soybeans which are unsuitable for processing into edible soy flour, as well as any weed seeds removed from the soybeans, the soybean hulls, and any soy flour which must be rejected because it does not meet established specifications for food use.

Soybean processing consultants have estimated that a soybean processing plant producing soy flour can tolerate 25 to 30 percent of its total soy meal production as premium grade soy flour without impairing the nutritional quality or value of the soy meal.[9/] Therefore, in addition to producing 8,500 tons of soy flour, either enough more soybeans must be processed to utilize the hulls and other byproducts from the soy flour operation in the soy meal, or some of the hulls must either be discarded or utilized for a lower value use.

In the United States soybean hulls--called soy millfeed--are sold as a feed ingredient for cattle rations. Soy millfeed is lower in protein and energy and higher in fiber than soy meal and sells at a much lower price. It is unsuitable for use in poultry rations, and since cattle are mostly grass-fed in Bolivia, the marketability of such an ingredient is unknown at this time. Therefore, in addition to the production of 8,500 tons of soy flour it would be desirable to be able to process enough more soybeans to utilize all of the hulls in the soybean meal without impairing the value of the soybean meal.

[9/] Summary of Plant Visit to SAO--Santa Cruz, Bolivia, for USDA/SEA, USDA P.O. 40-9AHZ-8-2424. EMI Corp., Des Plaines, IL, Sept. 22, 1978.

Currently, an estimated 12 to 15 thousand tons of soybean meal is utilized by the mixed feed industry at prices that are profitable to soybean producers and processers.[10/] There is also a market for soybean meal in Northern Chile where Bolivia, because of its location, has a competitive advantage over other suppliers of soybean meal.

According to estimates by officials of SAO, to achieve an annual production of 8,500 tons of soy flour without impairing the quality of soybean meal produced in the same plant would require the processing of 30,000 tons of soybeans. This would result in 14,900 tons of meal with a hull content of 7.9 percent.

Production of 8,500 tons of soy flour matches the goal of providing 5 percent soy flour to add to the current estimated annual production of 170,000 tons of wheat flour. Production of 14,900 tons of soy meal is only slightly higher than the current annual internal demand. Furthermore, what is not used internally can be exported to Northern Chile, although at somewhat lower returns. The 30,000 tons of soybeans required seem to be well within the production potential for Bolivia. In addition, this quantity of soybeans corresponds to the annual capacity of the SAO plant when also processing enough cottonseed (20,000 tons) to produce a blended oil of optimum quality characteristics. The oil yield from 30,000 tons of soybeans would be about 6,000 tons which is nearly half of the current estimated domestic demand for edible oils.

The demand for soybean meal in Bolivia for use in mixed feeds reportedly is escalating at a rate of 15 percent per year. With

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[10/] Reported by an oilseed processor and a mixed feed manufacturer.

population increases and increases in demand, the use of wheat flour is increasing at a rate of about 5 percent per year. If these rates of increase continue, the increased production of soybean meal, to satisfy the growing demand, could continue to absorb the hulls from the increased soy flour production that would be required without impairing the value of the soy meal.

REQUIREMENTS AND INVESTMENT COSTS FOR MODIFYING THE SAO PLANT TO PRODUCE SOY FLOUR

None of the oilseed processing plants in Bolivia are equipped to produce soy flour. To produce 8,500 tons of soy flour per year would require the modification of one or more of the existing soybean processing plants. This quantity of soy flour can be produced most economically in only one plant; therefore, for purposes of this analysis, it has been assumed that only one plant would be modified.

On the basis of discussions with officials of the Ministerio de Industria, Comercio, y Turismo (MICT), it was decided to select the plant of the Sociedad Aceitera del Oriente (SAO) for an analysis of costs of producing soy flour. This plant is a modern, solvent extraction plant with a processing capacity of 150 tons of soybeans per day, and is located in Santa Cruz near the area where most soybeans in Bolivia are currently grown.

The only other plant which it would be technically feasible to consider for producing the required quantity of soy flour is located in Villamontes, near the Argentine border. This plant is owned and operated by the Corporacion Boliviano de Fomento (CBF), a government corporation. Although GOB plans call for the production of soybeans on newly irrigated land in

the Villamontes area, this production has not yet been achieved. Shipments of soybeans from Santa Cruz, south to Villamontes, would require backhauling of the soy flour and other soy products to the major internal markets. Therefore, until such time as sizeable production of soybeans in the Villamontes area has been achieved, it would be uneconomic to use the CBF plant for the production of soy flour. At that time, if additional soy flour processing capacity is required, consideration should be given to modifying the CBF plant for this purpose.

Recently a soybean processing consultant, retained by the Western Regional Research Center, USDA, visited Santa Cruz, Bolivia, to investigate the existing SAO plant to determine the modifications that would be required to make it possible for this plant to produce soy flour suitable for human consumption. The results of this investigation have been presented in 2 reports.[11/] These reports contain descriptions of the required modifications, equipment requirements, process flow sheets, and estimated prices of the major items of required equipment, F.O.B. Carrier, U.S. Port of Embarkation. The prices for this equipment are summarized in table 2.

The modifications proposed by EMI for the SAO plant consist of additional equipment for cleaning beans, for dehulling and hull toasting, for flash desolventizing the extracted soy flakes and for grinding the desolventized flakes into flour. This system is known as a head end

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[11/] Edible Protein Production System for USDA, Science and Education Administration, Western Regional Research Center, Proposal No. GE 2164, by EMI Disc Corporation, Sept. 22, 1978; and Summary of Plant Visit to SAO . . . op. cit.

Table 2. Major equipment requirements and prices to modify the SAO plant, Santa Cruz, Bolivia, to produce soy flour, October 1978.

Item	Price[1/]
	Dollars
Preparation Room Process Modifications	
(Capacity: 150 tons per day)	250,100
EMI Flash Desolventizing and Cooking System	
(Capacity: 100 tons per day)	254,600
EMI Flake Cooling and Flour Grinding System	
(Capacity: 50 tons per day)	294,100
Total	798,800

[1/] F.O.B. Carrier, U.S. P.O.E.

SOURCE: Summary of Plant Visit to SAO--Santa Cruz, Bolivia, for USDA/SEA, USDA P.O. 40-9AHZ-8-2424. EMI Corporation, Des Plaines, IL, Sept. 22, 1978.

dehulling system with flash desolventizing. A number of other systems have been developed for producing soy flour. Of these, SAO officials believe that at least 3 others should receive consideration. These three systems are head-end system without flash (solvent is removed by a desolventizer-toaster) and tail-end dehulling systems with and without flash. With the tail end systems hulls are removed after the desolventized soy flakes are ground into flour. The main components of these four systems that would be required to modify the SAO plant are shown in the diagrams in figure 1.

Selecting a system for making soy flour will be based on 3 major criteria as follows: (1) microbiological quality of the soy flour; (2) organoleptic characteristics of the products expected to be made from the flour, both initially and in the future; and (3) estimated costs of the flour.

Generally, the microbiological quality of soy flour would be improved if the hulls are removed from the beans at the head end of the process. If the solvent is removed from the extracted beans by a desolventizer-toaster (D-T) the microbiological quality of the soy flour would be expected to be better than that which was produced by a flash desolventizing system, because of the higher temperatures reached with the former. Also important to to achieving high standards of microbiological quality in soy flour are the selection and cleaning of the beans and general plant sanitation practices. A description of the plant modifications and practices required for achieving high microbiological standards in the SAO plant is contained in Mustakas et al.[12/]

With regard to organoleptic characteristics, flash desolventizing has the capability of producing a nearly white flour with a high

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[12/] Conversion of Soybean Extraction Plant in Bolivia to Production of Flours For Human Consumption. G. C. Mustakas E. D. Milligan J. Taborga A., D. A. Fellers. Proceedings Annual AOCS Meeting, April 29-May 31. 1979, San Francisco, CA. JAOCS February 1980; p. 55-58.

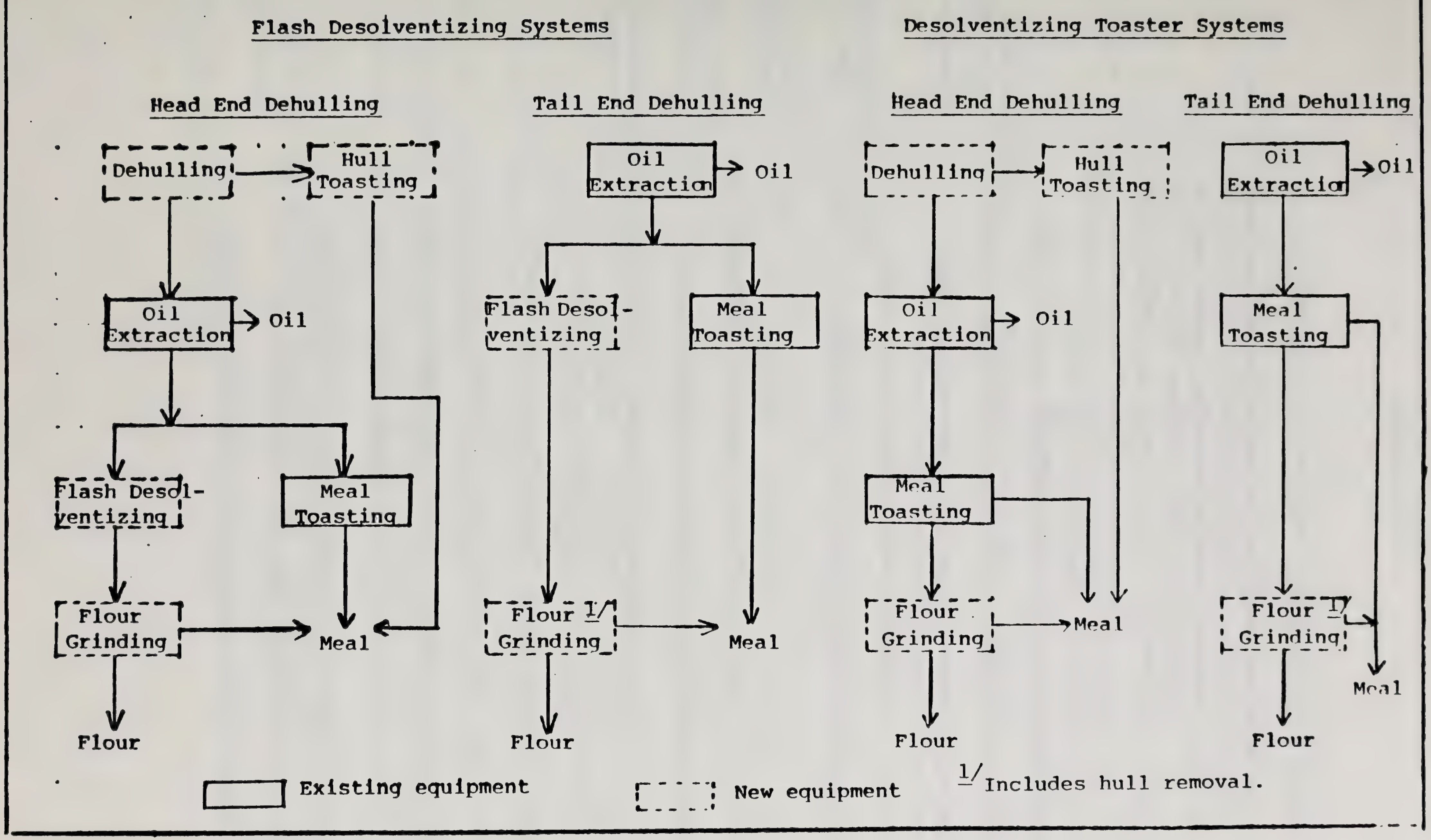

Figure 1. Flow diagrams of four possible ways to modify SAO plant to produce soy flour.

(up to 85) protein dispersibility index (PDI) and the flexibility to achieve lower PDI's for products in which high PDI's are not required. A number of products, e.g., textured vegetable proteins (TVP) require high PDI flours, whereas some products, e.g., bread, perform as well or better with PDI's in the mid to low ranges. Soy flour produced with the D-T system will be darker in appearance and have PDI's in the lower ranges, therefore, its uses are more limited. Further evaluations of the organoleptic acceptability of breads and other products made with soy flours produced in different ways are being made under Bolivian conditions as part of the WRRC/AID/GOB wheat foods project.

The difference in the cost of soy flour produced by different systems is another key factor in making a final selection among systems. Early in 1979, SAO made independent estimates of the investment cost of modifying its plant for producing soy flour with the four systems described above. Table 3 shows the capacity and investment required for each system. Costs include quoted prices of equipment delivered to Santa Cruz, estimated costs of installation, and estimated costs of required building modifications. Total investment costs range from a high of $1,035,000 for the flash desolventizer system with head end hull removal to a low of $435,000 for a desolventizer-toaster system with tail end hull removal.

Table 3. Investment required for all equipment, equipment installation and building modifications to enable SAO to produce 8,500 tons of soy flour per year by four different systems, Santa Cruz, Bolivia, March 1979.

Item or Operation and capacity per day	Flash desolventizing[1/] System: Head end dehulling	Flash desolventizing[1/] System: Tail end dehulling	Desolventizing-toaster[2/] System: Head end dehulling	Desolventizing-toaster[2/] System: Tail end dehulling
	Dollars			
Dehulling/Hull toasting (150 tons) (20 tons)	300,000	---	300,000	---
Flash desolventizing (100 tons)	300,000	300,000	---	---
Flour grinding (50 tons)	180,000	225,000[3/]	180,000	225,000[3/]
Building modification & laboratory	255,000	230,000	230,000	210,000
Total	1,035,000	755,000	710,000	435,000

[1/] Only extracted soybean flakes to be made into soy flour would be flash desolventized. A desolventizer-toaster (D-T) system, already in place at the SAO plant, would be used for removing solvent from extracted soy flakes that are used for soybean meal.

[2/] All extracted soy flakes would be desolventized with the D-T system now in place at the SAO plant whether they are to be used for soy flour or soy meal.

[3/] Includes hull removal system.

ANNUAL OPERATING COSTS

As indicated above, the SAO plant, when operating at capacity, would operate for 200 days on soybeans and 100 days on cottonseed to achieve a blend of oil with optimum characteristics. The processing capacity for soybeans is 150 tons per day, or 30,000 tons per year. For purposes of this analysis it is assumed that this is the capacity of the plant and that the soy flour grinder will be operated at capacity rates. According to SAO these rates would be 42.5 tons of soy flour per day for the tail end hull removal systems and 45 tons per day for the head end systems. Thus, to produce the estimated 8,500 tons of flour required for 5 percent addition of soy flour to all wheat flour would require that the tail end system produce soy flour for all 200 days that the plant processes soybeans, whereas with the head end system the required quantity of flour could be produced in somewhat less than 190 days of the 200 days of the soybean processing campaign.

To compute annual costs for the soy flour operation--that is, the additional costs that would be incurred by SAO to produce soy flour--estimates must be made of the costs of a number of factors including depreciation, interest on capital, raw material, labor, utilities, packaging, repairs, etc. The rates or costs used for these factor inputs are given in table 4.

Table 4. Factor inputs and their rates or costs for processing soy flour in modified SAO plant, Santa Cruz, Bolivia, March 1979.

Item	Rate or Cost
Raw material (soybean meal)	$180 per ton
Labor (includes all fringe benefits)	$5,000 per worker per year
Depreciation	
Equipment (8 year life)	12.5 percent of investment per year
Buildings (25 year life)	4 percent of investment per year
Interest on Investment	15 percent per year on undepreciated balance (7.5 percent per year on total investment)
Utilities	
Electricity	$0.03 per KWH
Steam	None additional required
Property Taxes	None in Bolivia
Packaging (1 quintal cotton bags, 21.74 bags per ton)	$0.765 each $16.60 per ton (not allowing for possible reuse)
All other (Includes office, marketing, working capital, fixed maintenance, and insurance expenses and contingencies)	Estimated at 10 percent of investment

Raw material--that is the soybean meal which would be used for producing soy flour--would be the largest single cost item and the most controversial to estimate. Although the domestic price of soybean meal is fixed by the government at $245 per ton, apparently this price is subject to some negotiation between buyer and seller. In addition, some soybean meal is exported to Northern Chile. This meal sells for the world market price plus a subsidy from the GOB to the seller of 25 percent of the price delivered to the Chilean border. In March 1979 the price that SAO was receiving from Chile was $200 per ton at the border, plus the government subsidy of $50 per ton. If this exported meal were used for converting into soy flour, transportation costs to the Chilean border and some other costs would not have to be incurred; therefore, the value of this meal at the SAO plant can be assumed to be equivalent to $250 per ton, less all of these costs. This results in a value of $180 per ton for the soy meal at the SAO plant. The computations for arriving at this figure are given in table 5.

It could be argued that the $50 subsidy should be deducted from the export price, to arrive at a fair price for the soybean meal which is to be used as the raw material for converting into soy flour. Thus, prices ranging from $130 to $245 per ton could all be considered logical prices for the soy meal to be used for soy flour manufacture. The author of this paper and the officials of SAO, decided that $180 per ton was justifiable; therefore, it was chosen for the computations of total soy flour costs. Estimates of the total costs for soy flour using other prices for the raw material can easily be made.

Table 5. Value of soy meal at the SAO plant based on price received at Chilean border, plus subsidy, less export costs, Santa Cruz, Bolivia, March 1979.

Item	Cost per ton
	Dollars
Price of soy meal c.i.f. Chilean border	200.00
Subsidy paid to SAO by GOB	50.00
Gross income to SAO	250.00
Export expenses	
Truck freight to border	54.00
Bags	9.00
Loading, custom fees, analyses, etc.	0.85
Insurance	2.40
Other expenses (TLX, etc.)	3.75
Total expenses	70.00
Net Income	180.00

Annual costs of producing soy flour with each of the four systems are based on the operational specifications of the systems and the rates or costs of the factor inputs discussed above. In addition to the annual raw material cost, estimates of the annual costs of each factor and a total annual cost for producing flour in the modified SAO plant are given in table 6 for each of four systems.

SOY FLOUR COSTS

To arrive at a cost per ton of flour, annual costs are divided by annual production. For each system it is assumed that the annual production of soy flour will be 8500 tons. Costs per ton range from a high of $241.77 when using flash desolventizing with head end dehulling to a low of $221.04 without flash and tail end dehulling (table 6).

Transportation Costs

In addition to the costs of production, soy flour must be transported to the flour mills to be blended with wheat flour. Flour mills are located in the principal city of seven of the nine Departments of Bolivia, with transport costs from Santa Cruz to each varying widely. An average cost of transportation per ton of soy flour to the flour mills can be computed by weighting the cost of transport to each of the seven cities with the milling capacity of the flour mills in those cities. The flour milling capacities, freight rates, and weighted average cost of transport of soy flour from Santa Cruz to all flour mills are given in table 7. When the average cost of transportation--$24.24 per ton--is added to the estimated costs of producing soy flour by each of the four systems, the cost of soy flour delivered to the flour mills ranges from a high of $266.01 to a low of $245.28 per ton.

Table 6. Annual costs of producing 8500 tons of soy flour: estimates for four different systems in modified SAO plant, Santa Cruz, Bolivia, 1979.

	Annual Costs			
	Flash desolventizing system		Desolventizing-toaster system	
Item[1]	Head end dehulling	Tail end dehulling	Head end dehulling	Tail end dehulling
	--------------------Dollars--------------------			
Fixed costs				
Depreciation	107,700	74,825	69,200	36,525
Interest	77,625	56,625	53,250	32,625
All other	103,500	75,500	71,000	43,500
Subtotal	288,825	206,950	193,450	112,650
Variable costs				
Raw material	1,530,000	1,530,000	1,530,000	1,530,000
Labor[2]	70,000	70,000	70,000	70,000
Utilities[3]	25,200	25,200	25,200	25,200
Packaging	141,100	141,100	141,100	141,000
Subtotal	1,766,200	1,766,200	1,766,200	1,766,200
Total	2,055,025	1,973,150	1,959,650	1,878,850
Cost per ton	241.77	232.14	230.55	221.04

1/ See table 4 for rates, use life and factor inputs.

2/ Based on 2 shifts per day with 7 workers per shift.

3/ Electricity only. Based on an average of estimates by EMI and SAO of connected horsepower of electric motors.

Table 7. Weighted average cost of transporting soy flour from Santa Cruz to flour mills in Bolivia weighted by installed flour milling capacity in each location, 1979

City	Percent of flour milling capacity	Freight costs per ton	Weighted cost per ton
	Percent	Dollars	Dollars
La Paz	42	29.31	12.31
Oruro	24	27.71	6.65
Cochabamba[1/]	14	18.12	2.54
Santa Cruz	14	6.18	.87
Potosi	3	27.71	.83
Tarija	2	42.63	.85
Sucre	1	19.18	.19
Total	100		24.24

[1/] The Departments of Pando and Beni receive their flour supplies from Cochabamba.

SOURCE: SAO

Costs of Blending Soy Flour with Wheat Flour

In addition to the costs of soy flour, f.o.b., Santa Cruz, and the transportation costs to flour mills, there would be a cost for handling and blending the soy flour at the flour mills. Currently the government pays millers a fixed fee for handling and milling wheat into flour. This fee is based on estimated costs of $26.32 per ton of wheat, plus a margin of $11.67, less $8.63 for the value of byproducts (bran, etc.). This comes to a total of $29.36 per ton of wheat milled. At 72 percent flour extraction, the fee per ton of flour comes to $40.78. A fee for blending soy flour with wheat flour also would have to be paid.

It is unclear at this time what services and materials the millers provide for the fee they are paid. However, for each ton of soy flour handled by the flour millers, some of these services, e.g , milling, would not have to be provided. On the other hand, to blend soy flour with wheat flour, the millers would have to install blending equipment in their mills and would have to forego the fee that they would normally receive for milling the quantity of wheat that would be replaced by the addition of 5 percent soy flour. Therefore, the fee that millers receive for blending soy flour with wheat should take all of these factors into consideration.

Impact of Dough Conditioners on Cost

At this time it has not been determined whether a dough conditioner, such as SSL, would be required to achieve acceptable organoleptic quality

in breads and other flour products made from soy fortified flour under Bolivian conditions. If SSL is required as a dough conditioner it would add considerably to the costs of the program. The price of SSL in large quantities being quoted in Santa Cruz early in 1979 was $2,640 per ton. Assuming that 0.25 percent SSL would have to be added to composite flour containing 5 percent soy flour, the amount of SSL required for fortifying all flour currently produced in Bolivia--170,000 tons--would be 425 tons. This would cost a total of $1,122,000 and, if added to soy flour, would raise the total cost of the soy flour-SSL blend by $125.71 per ton.

Furthermore, since SSL would have to be imported by Bolivia and paid for with foreign exchange this would dilute some of the balance of payments benefits that would accrue by the partial substitution of domestically produced soy flour for wheat flour made with imported wheat. As a consequence, one of the objectives of the baking tests being conducted under the project is to determine whether acceptable breads and other flour products can be made from composite flours either without the use of dough conditioner or with a lower cost dough conditioner.

Comparative Costs of Wheat Flour and Soy Flour

Since wheat and wheat flour prices and sales are administered by the government, the relative costs to the government for wheat flour and soy flour would seem to be an important criteria for deciding on a composite flour program using soy flour.

The price that bakers and other flour users pay for wheat flour is fixed by the government. Wheat is purchased by the government and delivered to the flour mills at government expense, and as indicated above, the

government pays the flour millers a fixed fee for their services. Flour is sold at a fixed price with receipts remitted to the government which either absorbs any costs above this price or retains any profits.

Still to be determined is the cost of the flour to the government and how this compares with the estimated costs of soy flour. The difference in these costs would provide a basis for estimating the costs (or savings) to the government of a program to fortify all wheat flour with 5 percent soy flour. This cost difference and the estimated costs, and strategy, for blending soy flour and dough conditioners with wheat flour will be the subject of a subsequent report.

Appendix B-8

THE POTENTIAL NUTRITIONAL IMPACT OF THE WHEAT FLOUR FORTIFICATION PROJECT IN BOLIVIA

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INTRODUCTION

Health and well-being of Bolivians are dependent upon many interrelated factors. Some of the major factors are shown on Slide 1. Nutritional

SLIDE 1

status plays a critical role, but well-being is also a function of several other factors including public health status, sanitation and economic level

This paper will discuss the potential nutritional effects of increasin the level of nutrients in wheat flour in Bolivia. We will specifically examine the effects of: (1) adding select vitamins and minerals to wheat flour, and (2) replacing wheat flour with limited quantities of soy flour. Some discussion will also be devoted to the partial replacement of wheat flour with other ingredients such as rice or quinoa.

NUTRITIONAL BACKGROUND

Nutritional needs of any population are generally greater among certain subgroups such as small children less than six years of age, and women of childbearing age. These subgroups are termed target groups. Target groups have been defined by the Government of Bolivia in its 5-year Food and Nutrition Plan (PIA/PNAN, 1976) as those living in rural areas, those less

than 5 years of age, pregnant and lactating women, and school children, 5-15 years of age. The Division of Nutrition, Ministry of Social Welfare and Public Health and USAID/Bolivia, also include poor urban groups in their definition of target groups. For purposes of reference, we will describe specific nutritional impact upon the young child, less than six and women, 20-29 years of age.

Information on the nutritional status of Bolivians is based on a variety of earlier studies which have been summarized in the Five Year Food and Nutrition Plan (PIA/PNAN, 1976-1980), the USAID/Bolivian Nutrition Sector Assessment (1976), and reviewed and critiqued in a WRRC assessment report (Fellers et al., 1977). In 1977, Trowbridge and Haverberg also reviewed available nutritional data and examined various approaches for collecting data in Bolivia.

The significance of nutritional deficiencies in Bolivia may be gleaned from the study of Puffer and Serrano (1973). Their data indicated that malnutrition was an underlying or associated cause in from 30-36% of mortalities in those less than 5 years of age. In general, the most common nutritional problems in Bolivia are protein-calorie malnutrition in the young child, iron deficiency anemia in pregnant and lactating women, and goiter. Limited data gathered in the 1960's suggest that the Bolivian diet is low in vitamin A, calcium, and possibly riboflavin. Data on nutritional intake of other B vitamins is limited.

Nutritional inadequacies may be dealt with in several ways; i.e., increase the quantity of food consumed, increase the consumption of foods with high concentrations of major limiting nutrients, or fortify

foods which are commonly consumed with the needed nutrients. This paper will discuss efforts which utilize the two latter approaches. Economic, technological, and cultural factors ultimately determine the most appropriate method of enhancing nutritional status.

POTENTIAL IMPACT OF THE NUTRITIONAL IMPROVEMENT OF WHEAT FLOUR

For purposes of this discussion, we will presume that approximately 170,000 metric tons of the wheat flour milled in Bolivia could be nutritionally enriched. A general figure of 5,000,000 will be used for total population. Thus, ≈93 g of this wheat flour is available/capita/day. Although this is an average which will be used for purposes of comparison, it should be recognized that some sectors of the population will consume more and others less. We should always keep in mind, however, that Bolivia is unique because of its markedly different regions which influence nutritional indices and food consumption patterns.

Enrichment with Select Vitamins and Minerals

One effective method of enhancing select vitamin and mineral content of the Bolivian diet is by enriching wheat flour. Some of the nutrients which could be added to wheat flour are cited in Table I.

TABLE I. ENRICHMENT LEVELS

Nutrient	Wheat Flour	6% Soy Fortified Wheat Flour
	---------------mg/lb. flour---------------	
Thiamine (B_1)	2.9	2.5
Riboflavin (B_2)	1.8	1.5
Niacin	24.0	20
Iron	13.0-16.5	13.0-16.5
Calcium	500-625	500-1107
	----------------IU/lb. flour-------------	
Vitamin A	4,000-6,000	4,000-6,000

The enrichment levels are those currently applicable to U.S. Export Wheat Flour and 6% soy-fortified wheat flour as used by ASCS (U.S. Agricultural Stabilization and Conservation Service). Standards used for U.S. domestic wheat flour are identical to those for the export flour with the exception of calcium which is 960 mg in the case of U.S. domestic wheat. If we calculate the additional quantities of these nutrients which would be available (Table II) it is apparent that, in most instances, the increases are significant. This may be illustrated by determining the proportion of the recommended nutrient intake (GOB/USAID, 1978) for select age groups living at average annual temperatures of 10°C. which would be met by these increased levels. We will use the soy fortified flour as the example

TABLE II. ADDITIONAL NUTRIENTS CONTRIBUTED TO THE AVERAGE BOLIVIAN DIET BY WHEAT FLOUR ENRICHMENT

Nutrient	Wheat Flour	6% Soy Fortified Wheat Flour
	------------------mg/capita/day------------	
Thiamine	0.59	0.51
Riboflavin	0.37	0.38
Niacin	4.92	4.1
Iron	2.67-3.38	2.67-3.38
Calcium	102.5-128.1	102.5-226.9
	----------------IU/capita/day-------------	
Vitamin A	820-1230	820-1230

(Table III). Values in Table III would be somewhat higher if enrichment levels for wheat flour and average temperatures of 20 or 25°C. were used.

TABLE III. CONTRIBUTION OF WHEAT FLOUR ENRICHMENT PROGRAM TO RECOMMENDED NUTRIENT INTAKE

Nutrient	1-2 Years	3-4 Years	Women (20-29 Years)
	-------------% of Recommended Intake--------------		
Thiamine	128	85	64
Riboflavin	63	48	35
Niacin	58	44	31
Iron	33-42	33-42	13-16
Calcium	23-50	23-50	21-45
Vitamin A	41-62	41-62	15-23

The contribution of these nutrients is especially significant for the young child. Some 40% or more of the recommended intake for the three B vitamins, iron and vitamin A would be met for children 1-4 years of age. The incorporation of these nutrients is technologically feasible and currently practiced for a variety of baked wheat foods.

As with many enrichment programs, there is a cost factor involved. Some indication of relative costs of these nutrients may be gleaned from U.S. costs in mid 1979. The cost of enriching 100 pounds of flour with a premix of thiamine, riboflavin, niacin, and iron is approximately 4.4 ¢. Since the average Bolivian intake of 170,000 mT would be 74.8 lbs/year, the cost of enriching wheat flour with these nutrients would be about 3.3¢/capita/year. If calcium is added in the form of calcium chloride, at the level of 500 mg calcium/lb of flour, the cost would be approximately 0.66¢/capita/year. Thus, the total cost of the three B vitamins, iron, and calcium would be 3.96 or ≈ 4.0¢/capita/year. In light of the recognized need of Bolivians for additional nutrients, and major nutritional problems such as anemia, the investment in an enrichment program seems warranted both from a pragmatic and humanistic point of view.

Replacement of Wheat Flour with Soy Flour and Other Commodities

There are several reasons why Bolivia would benefit by replacing wheat flour with various ingredients. This paper will focus on the nutritional benefits, whereas remaining speakers will discuss other factors. Major nutritional considerations will focus upon changes in protein quantity, protein quality, and caloric content.

Compositional data used are shown in Table IV. Caloric value of the ingredients are typical of cereals and low-fat plant foods.

TABLE IV. COMPOSITIONAL DATA

Ingredient	Moisture (%)	Nitrogen (%)	Protein (%)	Calories[1] (Kcal/g)
Wheat Flour[2]	12.0	1.91	10.9	3.64
Soy Flour, defatted[1]	8.0	8.23	47.0	3.26
Rice, milled and polished[2]	13.0	1.13	6.7	3.63
Quinoa[2]	12.0	1.92	12.0	--

[1]USDA. 1975. Nutritive Value of American Foods. Agriculture Handbook No. 456, Washington, D.C.

[2]FAO. 1970. Amino Acid Content of Foods and Biological Data on Proteins. Rome, Italy.

For purposes of analysis, FAO average figures were used for protein and nitrogen content. Data for wheat flour are for 70-80% extraction flour. Factors used to convert nitrogen to protein are 5.7 for wheat flour, 5.71 for soy flour, 5.95 for rice and 6.25 for quinoa (FAO, 1970).

The effects of replacing 5% wheat flour with either soy, rice, or quinoa, as well as replacing 10% wheat flour with 5% each soy and rice are shown in Table V.

TABLE V. PROTEIN LEVEL AND QUANTITY OF PROTEIN IN 170,000 METRIC TONS OF WHEAT FLOUR MIXTURES

	Protein (%)	Quantity Protein (g/capita/day)
100% wheat flour	10.9	10.14
95% wheat, 5% soy	12.7	11.81
95% wheat, 5% rice	10.7	9.95
90% wheat, 5% soy, 5% rice	12.5	11.63
95% wheat, 5% quinoa	11.0	10.23

The incorporation of soy, either alone or with rice, significantly increases the protein content of the wheat-soy mixture. With the incorporation of rice, protein content is decreased slightly, whereas it is slightly increased when quinoa is added. These changes are shown diagramatically in the following slide (Slide 2), with percent substitution

SLIDE 2

of wheat on the horizontal axis and percent change in protein content on the vertical axis. The large increase resulting from the addition of soy, as well as the increases obtained with the addition of soy and rice in equal parts (soy-rice, 1:1) or in a 1:2 ratio are apparent. As indicated in the previous table, the addition of rice to wheat results in a slight decrease in protein content of the final mixture. The percent change in protein quantity when 5 and 10% of the wheat flour are replaced by soy or rice is shown in Table VI.

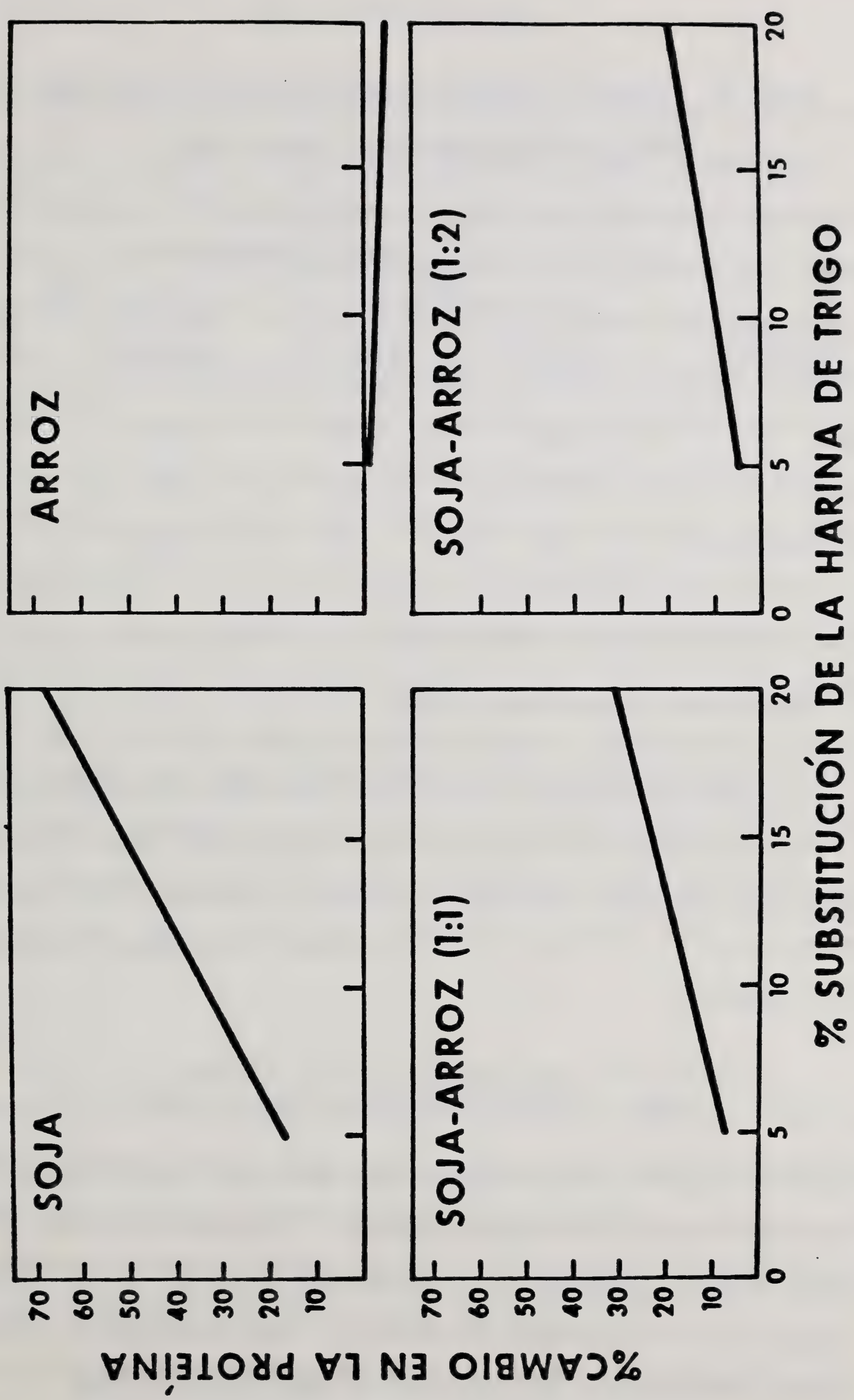
SOJA
ARROZ
SOJA-ARROZ (1:1)
SOJA-ARROZ (1:2)
70 60 50 40 30 20 10
0 5 10 15 20
% SUBSTITUCIÓN DE LA HARINA DE TRIGO
%CAMBIO EN LA PROTEÍNA

TABLE VI. CHANGED IN PROTEIN QUANTITY AND QUALITY WITH THE ADDITION OF SOY AND RICE TO WHEAT FLOUR

	Level of Replacement			
	5%		10%	
Replacement Ingredient	Protein Quantity[1]	Protein Quality[2]	Protein Quantity[1]	Protein Quality[2]
Soy	+17%	52	+33%	62
Rice	-2%	39	-4%	40
Soy:Rice (1:1)	+7%	46	+15%	53

[1]Represents % change from wheat flour.

[2]Protein Quality = amino acid score.

The same computer program which provides data and diagrams on the effects of substituting wheat flour with other ingredients also provides information on how protein quality has been effected (Betschart and Schatzki, 1979). Protein quality is evaluated by amino acid score in this example.

$$\text{Amino Acid Score} = \frac{\text{mg amino acid in test protein}}{\text{mg amino acid in reference protein}} \times 100$$

In these examples, the FAO Provisional Amino Acid Scoring Pattern (FAO, 1973) was used as the reference protein. The amino acid score for wheat flour (70-80% extraction) of 38 is markedly improved with the incorporation of soy flour or mixtures of rice and soy. Thus, both protein quantity and quality are enhanced when soy flour is added to wheat flour.

Digestibility of a food ingredient determines what proportion of the nutrients are available. Protein digestibility of wheat flour is 96% (Betschart et al., 1976), of milled, polished rice, 98% and of soy-cake from ≤ 80% to 92%. Recent studies conducted in Peru indicate that quinoa in combination with oats is not well digested by infants recovering from malnutrition (Lopez de Romana et al., 1978). The mean apparent absorption of nitrogen and fat was significantly lower on the quinoa-oats based diet than on a potato-wheat based diet. For infant feeding after the age of 1 year Lopez de Romana et al., recommend that the quinoa-oats based diet requires further evaluation.

As prices become available for wheat flour, defatted soy flour, rice flour and quinoa flour, we can make use of a linear program (Betschart and Schatzki, 1979) which can minimize cost, maximize protein content, caloric content or any single ingredient (e.g., soy or rice) when minimum levels for all variables except that which is being optimized are established as constraints. Cost estimates of wheat flour and soy flour will be discussed in a subsequent paper by Mr. Enochian.

SUMMARY

The potential nutritional impact of enriching the Bolivian wheat supply with select vitamins and minerals, and replacing wheat flour with defatted soy flour, rice flour and quinoa flour have been reviewed. Such a program would contribute towards reaching several of the goals of the Government of Bolivia's Five Year Plan including the following:

- To progressively increase the proportion of local foodstuffs that would meet the national demand for protein and calories

- To decrease the incidence of protein-caloric malnutrition (PCM), ...nutritional anemias, and specific vitamin deficiences.

Some of the more specific subgoals should also be impacted. These include:

- Reducing PCM in children under 6 years of age,
- Reducing the incidence of nutritional anemias and vitamin deficiencies in pregnant and lactating women,
- Raising per capita consumption of protein.

Although the nutritional improvement of wheat flour would not in itself attain these goals, it could play an important role in contributing to their attainment.

In closing, the opening statement will be reiterated, "Health and well being of Bolivians are dependent upon many interrelated factors...Nutrition plays a critical role but well-being is also a function of several other factors including public health status, sanitation and economic level."

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VITAMIN-MINERAL ENRICHMENT OF BOLIVIAN WHEAT FLOUR

September 27, 1979

SITUATION

Many surveys during the past two decades have delineated the nature and extent of nutritional deficiencies in Bolivia. In general, rural populations, those less than five years of age, pregnant and lactating females, schoolchildren (5-15 yrs), and urban poor are the groups most adversely effected, Infant mortality estimates of 145-250/1,000 live births provide some indication of public health and nutrition problems in Bolivia. Data gathered in La Paz and Viacha in 1973 showed that in 41-47% of the deaths in those under five years of age, malnutrition and immaturity were underlying or associated causes.

Primary nutritional problems identified in the Government of Bolivia's Five Year Food and Nutrition Plan (1976-1980) were protein-calorie malnutrition in the young child and iron deficiency anemia in pregnant and lactating females. Critical nutritional problems also included iodine deficiency, and less than adequate intake of vitamin A, calcium and the B vitamins, especially riboflavin (vitamin B_2). Current consensus of opinion among nutritionists in Bolivia is similar to the GOB assessment, with the exception that more prominence is given to problems with thiamine (vitamin B_1). The present program designed to describe, in detail, the nature and extent of iron deficiency anemia in Bolivia attests to the importance of this problem.

Specific cases indicating the extent of lowered intake of select nutrients emphasizes the magnitude of nutritional inadequacy in Bolivia. Iron deficiency anemia has been estimated to affect some 70% of pregnant women in 1975, 68% in 1980, and 65% in 1985. Data from several studies in the 1960's indicate calcium levels in the diet range from 15-77% of the recommended intake. Vitamin A intake appears to be low with intakes of 6-85% of recommended levels of consumption. Riboflavin content of the diet ranges from 30-160% of recommended intake.

Sufficient evidence exists to indicate that the Bolivian diet could be nutritionally improved with a vitamin/mineral enrichment program.

PROPOSED PROGRAM(S)

Bread is an appropriate vehicle for an enrichment program since it is consumed in sufficient quantities by all segments of the population, including preschool children.

Several alternate enrichment programs, with increasing quantities of nutrients are proposed. Suggested final levels of nutrients in wheat flour are shown in Table I. These values include nutrients present in the flour.

Appendix B-9

TABLE I

NUTRIENT	LEVEL (mg/lb flour)
Iron	13 - 16.5
Thiamine (B_1)	2.9
Riboflavim (B_2)	1.8
Niacin	24.0

Iron, alone, may be used to enrich wheat flour. In the example in Table I, 10 mg iron are added to wheat flour to attain levels indicated. Nutritional evidence overwhelmingly suggests that Bolivians, especiallv, women, would benefit from such a program. Iron may be incorporated in the form of ferrous sulfate ($FeSO_4$) which is more bioavailable than other forms of iron to be discussed. However, $FeSO_4$ is used most effectively when the required shelf life for the wheat flour is short, i.e., less than 60 days. If shelf life, and/or conditions suggest that $FeSO_4$ would not be appropriate, either reduced iron or electrolytic iron may be used. These forms are somewhat less bioavailable than $FeSO_4$ but are more stable during prolonged periods of storage. The Relative Biological Value (RBV) of reduced and electrolytic iron is approximately 40 and 60%, respectively, with RBV for $FeSO_4$ being 100%. The absolute bioavailability of $FeSO_4$ generally ranges from 5-15% depending on nutritional status of the individual and many other factors.

Other enrichment programs could consist of a) iron with the B vitamins thiamine, riboflavin and niacin, b) those nutrients in (a) plus vitamin A. The levels of nutrients discussed previously are routinely incorporated into wheat flour in many areas of the world and do not affect characteristics of the final bread.

A key issue is the cost/benefit ratio of incorporating these nutrients. Approximations of relative costs are summarized in the following table.

TABLE II

NUTRIENT	COST/100 lbs FLOUR	COST/225,000 MT FLOUR	COST/CAPITA/YR
	- - - - - - - - U. S. Dollars	- - - - - -	
Iron			
Ferrous Sulfate	0.014	70,000	0.014
Reduced Iron	0.0095	50,000	0.010
Electrolytic Iron	0.017	90,000	0.018
Iron ($FeSO_4$) Thiamine Riboflavin Niacin	0.044	240,000	0.048
Iron ($FeSO_4$) Thiamine Riboflavin Niacin Vitamin A	0.090	470,000	0.094

These cost approximations include shipping costs. The initial cost of iron enrichment is more than doubled by the addition of B vitamins, and this latter cost is again doubled with the inclusion of vitamin A. The investment cost per Bolivian on an annual basis, however, ranges from less than 1.0 to about 9.0¢ (U.S.). Total costs for a national enrichment program are calculated on the basis of 225,000 MT of wheat flour.

Savings in health costs, the potential for enhanced physical and mental capacity, and improvement in the plight of the young child, the pregnant woman and those most undernourished should warrant serious consideration of one of these programs.

RECOMMENDATIONS

All wheat flour should be enriched with ferrous sulfate with the addition of 10 mg/lb[1] of flour at the time of implementation of the composite flour program. This would require the installation of a microfeeder at each of 16 mills. The 1979 capital cost for such feeders is $2,500/feeder or a total of $40,000. However, technology is being developed which may allow iron to be added with the dough improver. Since it is anticipated that feeders would be installed for dough improvers as part of the composite flour program, there may be no need to install an additional feeder for enrichment with iron or other nutrients.

If financial resources allow, B vitamins should be included with the iron. Since these nutrients are added as one premix which includes the iron, there should not be a need for additional feeders beyond those discussed for iron alone.

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1. Equivalent to 27.2 mg $FeSO_4$

Protocol for Physiological Acceptance Test - Wheat-Soy and Wheat-Soy-Quinoa Breads. January 14, 1980

OBJECTIVE

To determine the physiological acceptance, by humans, of wheat breads containing soy and quinoa flour. See Appendix I for a description of the over-all project entitled, "Mejoramiento Nutricional de los Alimentos a Base de Harina de Trigo."

PLAN

General: Young children will consume products for 28 days that are made from either wheat flour alone, wheat flour (95%) and soy flour (5%), or wheat flour (90%), soy flour (5%) and quinoa flour (5%). Various indices of health and well being will be monitored to determine the physiological acceptance of wheat flour blends.

Preparation of Samples to be Tested:

One uniform, representative sample of Bolivian milled bread wheat flour will be used for this entire physiological study. Also, one uniform sample each of Bolivian soy flour and quinoa flour will be used. The three treatment samples will consist of: 100% wheat flour; 95% wheat flour plus 5% soy flour plus 60 parts per million (ppm) Bromolux; 90% wheat flour plus 5% soy flour plus 5% quinoa flour plus 60 ppm Bromolux. The wheat flour will be purchased by DGNT from a local supplier. DGNT will prepare the soy flour from toasted, defatted soy flakes provided by Sociedad Aceitera del Oriente (SAO), Santa Cruz, by a grinding and sieving process. DGNT will prepare quinoa flour from locally purchased Quinoa Real by washing in water to remove saponins, drying, milling and sieving. Bromolux is a commercial dough conditioner containing 50% potassium bromate and 50% inert salts. The blends will be prepared by DGNT in 400 pound batches with special attention to mixing to insure complete uniformity. Each of the three 400 pound lots will be coded in a manner such as: ▱ , +, and 0; and each bag in each lot will have the appropriate code.

The samples will then be delivered to the contractee who will store them off the floor in a cool, dry, aerated place. The code will not be known by either the contractee or the subjects who eat the breads.

Each child is to receive a minimum of 25% of his or her calories from the blends each day. Since the daily recommended intake is 1620 calories for children in the 5 to 6 yr. age group, this means they should get as a minimum, 405 calories each day from their respective blends. To obtain 405 calories each day, the children must receive a minimum of 111 grams of flour. This 111 grams of flour would make about 2 1/2 of the standard 60 gram marraquetas. In order to minimize disruption of the standard feeding patterns at the contractee's facility, determination of the specific wheat products to be fed is left to those responsible for planning and preparing the menu in cooperation with DGNT. However, a wheat product must be presented at 3 of the 4 daily meals as a minimum. No other flours such as Maisoy should be added to the treatment samples. Most breads will consist of the ingredients flour, water, yeast, salt and with sugar and fat optional. Examples of highly suitable wheat products for use in the physiological tests are marraquetas, loaf bread, empanadas, saltenas, and fideos.

Selection of Subjects:

The three flour samples will be evaluated by three groups of children during the same 28-day period. These children will be normal and healthy, 5-7 years of age, and all part of the same nursery school or school environment. There will be 15 children per treatment.

To ensure experimental objectivity and facilitate statistical analysis of data, children will be assigned to a specific treatment on the basis of select randomization. For example, stratification on the basis of age or sex will

be assigned to each treatment. This will be accomplished through the use of a random numbers scheme.

Sample Evaluation:

Wheat bread containing soy flour has been shown to be nutritious for humans. This study is designed to evaluate the response of Bolivians, living at high elevations, to such breads.

Criteria such as body temperature, signs of infections, listlessness, and vomiting are required to determine the general health status of subjects during the study. Food consumption patterns including quantity of bread products consumed are needed to keep records of any significant loss in appetite, as well as what portion of the tested samples were consumed. Information on menus used throughout the 28-day test period will be needed to determine the types of foods consumed along with the breads being tested. If there are any unusual physiological responses for a specific day or period of time, it is critical to have records of other foods consumed during that time.

Small portions of soybean flour are generally consumed by humans with no unusual physiological effects. Higher elevations, however, with lower atmospheric pressure may result in some slight effects on the gastrointestinal tract and normal stool patterns. Therefore, information on stomach cramps, stool frequency and consistency are necessary.

Care will be taken to ensure that all wheat products being evaluated will be consumed by subjects whenever possible. Records will be kept of all menus served at all meals throughout the study, indicating types of food and approximate serving/child, e.g., 1 glass of milk, 1 egg, 1 serving potatoes, etc. Information and data on subjects will be recorded during pre-study and post-study

physical examinations conducted by a physician. The pre-study examination will be conducted the day before the study officially begins, and the post-study examination will be conducted the day immediately following the completion of the study. Daily and weekly data and observations will be recorded by the contractee throughout the study. All information and data will be recorded on an information and data sheet to be kept for each child. Some of the information such as changes in bowel patterns may be obtained by interviewing the child. A sample copy of the information sheet is attached.

DGNT will assist in setting up the study and make weekly visits to the site of the study to review progress and advise on any problems that may arise.

Final Report:

A final report, submitted by the contractee to DGNT, will include the following:

- Decription of exact procedures used throughout all phases of the study, e.g., method used to bake and prepare wheat products, to select the sample populations, and to gather physiological data; menus of all meals served to subjects during the 28-day period.
- Completed Information and Data Chart for each child in the study.
- Written summary of study discussing data and interpretation of data. Specifically, contractee should comment on general acceptance of wheat products made from the three sample flours and any unusual responses which seem to be related to consumption of products from these flours.

Final statistical analysis and interpretation of data will be conducted by DGNT.

RECORD OF MENUS

(First Week)

DAY OF WEEK	MEAL NUMBER 1	2	3	4	Snacks
Monday					
Tuesday					
Wednesday					
Thursday					
Friday					
Saturday					
Sunday					

Appendix B-10

PHYSIOLOGICAL ACCEPTANCE TEST

INFORMATION AND DATA CHARTS

NAME ______________________________ ______________________________
Surname Christian Names

TREATMENT □ + ○
(circle one)

NAME ________________ ________________
Surname Christian Name(s)

MEDICAL EXAMINATION

AGE _____ YRS. _____ MOS. SEX ____F ____M

	PRE-STUDY	POST-STUDY
WEIGHT (Kg)		
HEIGHT (m)		
BODY TEMPERATURE (Oral) °C		
GENERAL HEALTH RECENT INFECTIONS (type & date)		
MOST RECENT EPISODE OF VOMITING (date)		
NORMAL BOWEL PATTERN (normal consistency, loose, diarrhea)		
HAVE ANY OF THE ABOVE SIGNIFICANTLY CHANGED BETWEEN PRE-STUDY AND POST-STUDY EXAMINATION? HOW HAVE THEY CHANGED?		
OTHER GENERAL COMMENTS		

NAME ______________ ______________
Surname Christian Names

OBSERVATIONS DURING STUDY

FIRST WEEK

DAY OF THE STUDY

DAILY OBSERVATION	1	2	3	4	5	6	7
BODY TEMPERATURE (oral, °C)							
GENERAL HEALTH Infections (type) Listless, Inactive Vomiting							
FOOD CONSUMPTION PATTERN (X)							
Consumed less food than normal							
Consumed all wheat products							
Consumed 2 wheat products							
Consumed 1 wheat product							
Consumed no wheat products							
STOOL PATTERN (by interview) Frequency, no. of times bowels moved/day.							
Consistency normal loose, e.g., diarrhea							
Stomach cramps							
OTHER COMMENTS							
WEEKLY OBSERVATIONS (First day of week) Body weight (Kg)							

Description of Project: "Mejoramiento Nutricional de Los Alimentos a Base de Harina de Trigo"

This Physiological Acceptance Test is part of a larger Government of Bolivia Project entitled, "Mejoramiento Nutricional de los Alimentos a Base de Harina de Trigo." The project director is the Director General, Ing. Gregorio Bernal, of the Direccion General de Normas y Tecnologia (DGNT), Ministerio de Industria, Comercio y Turismo. The Western Regional Research Center, Berkeley, California, provides technical assistance through the Health and Humanitarian Assistance Division, USAID, c/o The American Embassy.

In 1979, it was estimated that Bolivia would require 309,000 metric tons of wheat, of which 96% would have to be imported. At the official extraction rate of 72%, this wheat yields 222,480 MT of wheat flour. None of this wheat flour is enriched with vitamins or minerals. Bread production consumes 78% of the flour, pastas 18.5%, cookies and crackers 3.5%, and other uses 0.5%. These various wheat products provide one fourth to one third of the food calories and protein for the country.

The project seeks to improve the nutritional quality of wheat products through fortification of all wheat flour with 5% high protein defatted soy flour grown and processed in Bolivia and with iron, a mineral deficient in Bolivian diets as indicated by the high prevalence of anemia. In addition, the project seeks to further extend or substitute wheat flour by adding 5 to 10% of non-wheat flours prepared from domestically grown corn or quinoa or rice. It is anticipated that the various ingredients would be blended with the wheat flour to yield composite flour at the 16 wheat mills located throughout the country (Bolivia has the milling capacity to meet its wheat flour requirements). An oxidizing agent, potassium bromate, is added to the composite flours at about 30 parts per million as a dough

improver to overcome the deleterious effect on bread quality of diluting the wheat flour with soy and other non-wheat flours.

The project would impact favorably on three areas in Bolivia: nutrition, import substitution, and agricultural employment. A total substitution of 10% of the wheat flour would require 22,448 MT of domestically produced flours from soy, quinoa, corn and rice. Increased demand for these crops should improve agricultural employment opportunities. The addition of 5% soy increases the protein content of bread from 8% to 9.5% and substantially improves the nutritional quality of the protein. For an average person consuming about 170 grams of bread and other wheat products, per capita protein intake would be increased about 3 grams from 48 grams per day to 51 grams per day. This meets part of a national goal which is to increase protein intake to 56 grams per day. Iron enrichment at 10 mg per pound of flour would enable wheat products to provide up to 40% of the daily recommended intake of this nutrient in Bolivia while unenriched wheat products only provide up to 20%.

With respect to cost, delivered corn flour currently sells for 270 pesos per qq (100 pounds) and wheat flour 300 pesos. Detailed cost analysis resulted in estimates for delivered Bolivian, food grade, defatted soy flour of 260 pesos per qq (costs are before November 1979 devaluation). Detailed cost estimates have not been made for rice or quinoa flours but would be expected to be higher than wheat flour. Only 13 MT of potassium bromate is required for the entire program in Bolivia each year at a cost of about US$50,000. Ingredient cost for the iron enrichment would be on the order of US$70,000 per year. These cost data suggest, then, that certain enriched composite flours can probably be prepared and sold in Bolivia at no change in price from wheat flour.

Acceptability of the composite flour breads in limited tests has been good. A nationwide market acceptance test is being contracted with a Bolivian consulting firm to be carried out January - March 1980.

Following the completion of all the developmental and evaluational work, a national plan of implementation for composite flours will be prepared and presented for review by various governmental and private groups, and for decision on implementation by the government.

Appendix B-11

REPORT

PHYSIOLOGICAL ACCEPTANCE STUDY

Antoinette A. Betschart
Western Regional Research Center
Berkeley, California

The purpose of this study was to determine the physiological response to, and acceptance by young Bolivian boys of marraquetas containing either 5% soy flour or 5% soy and 5% quinoa flour. The subjects, 7-10 years of age, were accustomed to consuming three marraquetas per day. Subjects from Cuidad del Nino were randomly divided into three groups and fed three marraquetas per day made from (a) 100% wheat flour (control), (b) 95% wheat flour, 5% soy flour, and (c) 90% wheat flour, 5% soy flour and 5% quinoa flour. The soy and quinoa flours were prepared in Bolivia from locally grown crops. Marraquetas were baked and delivered to the subjects under the supervision of DGNT. Medical examinations were conducted just prior to, and at the completion of the study. Throughout the 28-day study, data were collected on each subject, including temperature, weight, number of marraquetas consumed, frequency of bowel movements, and consistency of stools. Daily menus were also recorded.

Results

Randomly selected subjects consisted mainly of 8 and 9 year olds (~2/3), with the remaining being 7 and 10 years of age. The pre-study exam indicated that bowel movements were normal for virtually all of the subjects.

Data on number of marraquetas consumed showed that 3 marraquetas were consumed by a majority of the subjects throughout the study. In terms of the number of occasions when subjects were expected to consume a marraqueta in this study, there were deviations from this pattern in 0.021, 0.019, and 0.015% of the time within the control, soy and soy-quinoa groups, respectively. Among these deviations, 70-79% of the subjects still consumed 2 1/2 marraquetas per day.

Throughout the study, mean number of bowel movements/day of subjects in the 5% soy or 5% soy-5% quinoa group were, generally, slightly higher than the control. The Student's t test showed that the number of stools produced by the groups consuming the soy and soy-quinoa marraquetas were higher compared to the normal group ($P < .05$). There were no significant differences between the soy and soy-quinoa groups.

Consistency of stools produced during the study was described as dry, normal, semi-liquid and liquid. The lack of a bowel movement on any particular day was also included in these data. When the data are summarized within each treatment group for the 28-day period, the results are as follows:

STOOL CONSISTENCY
(% of subjects)

	Liquid	Semi-Liquid	Normal	Dry	None
Control	1.7	11.7	39.3	31.1	16.2
5% soy	8.1	21.9	16.7	39.3	14.0
5% soy- -5% quinoa	7.6	23.6	14.0	45.5	9.3
Total for All Subjects	5.8	19.0	23.3	38.7	13.2

The consistency of stools from the soy and soy-quinoa groups was significantly different from the control during each of the four weeks (χ^2 $P < .05$). As with the number of stools, there were no significant differences between soy and soy quinoa groups.

The frequency of liquid and semi-liquid stools increased within the treatment groups (soy and soy-quinoa), whereas that of normal stools decreased when compared with control group. Although normal stools were the most common in the control group, dry stools were produced most frequently by subjects consuming soy and soy-quinoa supplemented breads. The decrease in normal stool patterns in the soy and soy-quinoa groups was mainly distributed among the semi-liquid and dry classifications, with a smaller portion being liquid. Subjects in both the soy and soy-quinoa groups exhibited somewhat similar trends in stool consistency.

If these data were examined on the basis of daily observations, it is apparent that the control group quite consistently had fewer liquid and semi-liquid stools than did the other two groups. From the 10th to the 28th day of the study, the control group produced many more normal stools than did those subjects consuming soy and soy-quinoa supplemented breads. After the 10th day, the soy and soy-quinoa groups generally produced more dry stools than the control.

Summary

Results of a 28-day study indicate that young Bolivian boys living on the Altiplano accept marraquetas containing 5% soy flour, or 5% soy and 5% quinoa flour as well as they do those made solely from wheat flour. Mean number of bowel movements per day was slightly higher in the soy and soy-quinoa groups than in the control. More dry, semi-liquid, and liquid, and less normal stools were produced by the soy and soy-quinoa groups than by the control.

This study has shown that the consumption of soy and soy-quinoa marraquetas is associated with alterations in stools of subjects. Subsequent data analyses may shed light on the nature of this association and possible causative factors.

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VERDE = 5% soy bread
ROJO = 100% wheat bread
AMARILLO = 5% soy & 5% quinoa bread

I N F O R M E

REPORT ON THE PHYSIOLOGICAL ACCEPTANCE STUDY

De acuerdo al borrador de convenio entre el Ministerio de Bienestar Social y Familia y el Ministerio de Industria Comercio y Turismo; el Ministerio a su cargo debía seleccionar 45 menores entre 7 y 10 años de la Ciudad del Niño en las mejores condiciones de salud posibles.

Los días 27, 28 y 29 del mes de Febrero del año en curso, mi persona juntamente la colaboración de la Señorita Miriam Díaz enfermera de la Institución, realizamos el correspondiente exámen médico y seleccionamos a los 45 menores.

Además del exámen médico clínico la Dra. Bertha Aguilar Bioquímica se desplazó y realizó exámenes coproparasitologicos; mas del 70% de los niños se encontraban parasitados, pero al ser completamente asintomáticos consideramos que no influirían en el estudio a realizarse.

Dentro del aspecto de salud oral también se hizo una revisión, ya que se considera que cualquier afección en la cavidad oral podría afectar la fase de masticación, por lo que consideramos este exámen importante.

Una vez seleccionados los 45 niños y llenada la correspondiente hoja, formulario Nº 1 que comprenda el exámen médico; que arrojó los siguientes resultados:

16	Menores	clinicamente sanos
17	"	con parasitosis asintomática
8	"	con tenasis
2	"	con desnutrición I
1	"	con laringitis
4	"	con papilomatósis
1	"	con sarcoptosis
1	"	con Impetigo

(Se debe nuevamente recalcar que ninguno de estos diagnosticos clínicos afectaría los resultados de la prueba); personeros del Ministerio de Industria realizarón la división de los 45 niños en tres grupos de 15 menores y se los denominó por colores: rojo, amarillo y verde.

El día 4 de Marzo comenzó el estudio propiamente dicho; el Ministerio de Industria proporcionó cada día los tres tipos de pan para el consumo de los menores, el día 21 de Marzo por razones de fuerza mayor no llegó el pán, pero con sobrantes del día anterior se resolvió este problema.

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La señora Wilma de Yugra conjuntamente con la señorita Miriam Díaz, se encargarón de tomar y registrar en el formulario Nº 2 en forma diaria los siguientes datos:

1.- Temperatuta axilar
2.- Consistencia y frecuencia de deposiciones
3.- Consumo de pân diario
4.- Falta de apetito
5.- Malestar, dolor abdominal y flatudencia
6.- Algún otro síntoma como ser vómitos
7.- El peso se lo tomó en forma semanal

Los resultados de todas estas variables podriamos resumirlas de la siguiente manera:

1.- Temperatura; ninguno de los menores padeció de alza térmica.
2.- La consistencia de las deposiciones varió en las tres grupos, en uno más que otros, pero la frecuencia fué normal.

(Se adjunta gráficos demostrativos sobre consistencia de deposiciones de los tres grupos Gráfico Nº 1 Grupo Rojo, Nº2 Amarillo , Nº 3 Verde).

Si analizamos el gráfico 1 se ve que todos los niños presentarón más deposiciones secas, normales, la frecuencia también fué de una vez al día.

Como se verá en el gráfico 2 que corresponde al grupo amarillo, aunque la mayoría de las menores tienen mas deposiciones secas existen 2 niños con más deposiciones semiliquidas; por otro lado tambièn hay niños que presentân un buén número de deposiciones líquidas , de todas maneras debemos indicar que aunque la consistencia a variado la frecuencia contínua siendo normal de 1 véz al día y también debemos decir que la consistencia semilíquida o líquida de las deposiciones no es diaria.

Ahora pasemos a analizar el Gráfico 3 que corresponde al - grupo verde en el cual también el mayor número de menores presentó deposiciones secas, pero existierón por lo menos 4 menores que presentarón mas deposiciones semilíquidas, así como líquidas.

La frecuencia comooen los anteriores grupos fué normal, una véz al día.

La recolección de de datos sobre consistencia y frecuencia - de deposiciones fué por interrogatorio directo a los menores, por parte de los regentes del hogar.

3.- El consumo da pán fué de 3 unidades por día, este control fué realizado por la enfermera, los regentes y la Señora Yucra.

El resultado obtenido es de que los 3 grupos han consumido - en forma uniforme sus 3 unidades de pan sin que haya existido rechazo por parte de ningún menor ya sea al sabor o a la presentación .

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4.- Tampoco en ninguno de los menores el consumo del pán ha producido falta de apetito.

5.- Síntomas de dolor abdominal se presentarón en dos menores del grupo Rojo y en un menor del grupo Amarillo , - fuerón de tipo cólico, manifiesto más por las noches , este dolor solo se presentó en una o dos oportunidades.

6.- Otros síntomas, solo podiamos indicar mareas y vómitos en uno de los menores del grupo Rojo en dos oportunidades

Todos los datos de sintomatología fuerón obtenidos mediante interrogatorio directo a los menores, por parte de sus regentes y registrados en el formulario Nº 2 en forma diaria, por parte de la señorita enfermera.

7.- El peso como anteriormente se indicó fué obtenido en forma semanal por la Señora de Yucra, con los menores en ropa interior y todas las veces antes del desayuno.

Asimismo se tomó el correspondiente peso en el exámen médico - del pre-estudio y del post-estudio .

Si los gráficos 4,5 y 6 nos darán una muestra sobre esta variable.

Si analizamos el gráfico 4 que corresponde al grupo rojo, veremos que en la mayoría de los menores existe incremento que aunque mínimo es lo que corresponde a su edad. Solamente un menor tubo un descenso de muy pocos gramos.

El gráfico 5 que corresponde al grupo amarillo, vemos que en 4 menores hay descenso del peso este es mínimo.

El gráfico 6 que es el del grupo verde, solo en un caso existe disminución de peso, en el resto existe aumento que por supuesto es mínimo.

A parte de la ingestión del pan, los niños recibierón su dieta corriente,; desayuno, almuerzo, té, cena y un refrigerio, el cual - fué preparado por la Lic. Silvia Brun, que además supervisó en forma diaria su preparado y registro en los formularios correspondientes - el menú diario que recibierón los menores, (adjunto informe nutricional).

Despúes de 28 días y concluido el estudio, en fecha 1 de Abril se procedió nuevamente al exámen médico cuyos resultados se registrarón en el correspondiente formulario y en el cual no hubo ninguna variación en relación al primer exámen.

CONCLUSIONES

1) Engeneral los menores que fuerón escogidos gozaban de buén estado de salud, algunos condiagnósticos de proceso patológico; parasitosis; no influyerón en el estudio.

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2) Todos los menores ingirierón normalmente los 3 tipos de pán, sin que al parecer hayan notado diferencias en el sabor u otras.

3) En general la ingestión del pán no produjo transtornos dando lugar a la presentación de síntomas gastrointestinales.

4) Aunque notamos diferencias en cuanto a la consistencia de las deposiciones en los 3 grupos, como anteriormente se explicó en los gráficos y el análisis de éstos, las deposiciones semilíquidas y líquidas presentes en algunos menores, sobre todo de los grupos amarillo y verde, no pueden considerarse como diarrea, ya que la frecuencia ha sido normal, de una vez al día y por otro lado la consistencia semilíquida o líquida no ha sido en días contínuos, sino que las deposiciones se han normalizado de un día para otro.

5) La variable peso, de ninguna manera puede ser un índice al cual, se le deba dar máxima importancia ya que el aumento de peso en niños mayores de 6 años es infimo en un mes, de todas maneras como se ha analizado muy pocos menores, han disminuido de peso y su rebaja ha sido mínima.

La conclusión final podríamos resumirla en los siguientes términos: la aceptación fisiológica por parte de los menores de la "Ciudad del Niño", a los tres grupos de pán en base a harina que trigo, soya y quínua,ha sido similar, pero el estudio no puede ser concluyente por el tiempo corto de la prueba y por que no se ha continuádo con el control de los niños, una véz suspendida la provisión del pán, para ver si han existido cambios especialmente en cuanto a la consistencia de las deposiciones, que es la variable donde han existido más cambios en los tres grupos.

RECOMENDACIONES:

1) Debemos solicitar al Ministerio de Industria, Comercio y Turismo la provisión de éstos tres tipos de pán, para la alimentación de menores de otros hogares por el lapso de por lo menos tres meses, ya que el pán de trigo, soya y quínua proporciona mayor cantidad de calorías y proteinas y si realmente se llega a una conclusión definitiva de que es perfectamente tolerado sería ideal, para el consumo diario de los menores.

2) El esfuerzo del Ministerio tanto en cuanto a nuestros menores, para los cuales siempre es un stress cualquier tipo de estudio, y para el personal que desarrolla la actividad, debe tener su compensación, por lo que sugiero se solicite al Ministerio de Industrio la dotación de material médico que repercutirá en beneficio de los menores, es éste sentido algunas de las necesidades serían:

a) Balanza de pié con tallímetro
b) Estuche de diagnóstico
c) Tensiómetro
e) Estetoscopio

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Con este material el Consultorio de la Ciudad del Niño, estaría completo. (adjunto cuadros gráficos e informe nutricional).

M Díaz C.

Miriam Díaz Cossío
ENFERMERA

Dr. Roberto Velasco Tellez
JEFE MEDICO REGIONAL DE LA PAZ
Junta Nacional de Acción Social

NOTA: Cave recalcar la eficiente colaboración de la Lic. Silvia Brun; Nutricionista, de la señorita Miriam Díaz Enfermera, del señor Lucio Quispe, chofer , quienes en todo momento se desempeñarón con responsabilidad y sacrificio.

c.c. J.M.N.
c.c. Min. Industria Comercio
c.c. Archivo

Min. Bienestar Social
Convenio
Min. Industria, Com. y Turs.

PROGRAMA INTERMINISTERIAL
PROGRAMA DE MEJORAMIENTO NUTRICIONAL A BASE DE PAN DE TRIGO-SOYA-QUINUA
PARA MENORES INTERNOS DE LA CIUDAD DEL NIÑO

	GRUPO ROJO Wheat Bread	PRE-ESTUDIO				Fecha: Deposiciones		DIAGNOSTICO	POST-ESTUDIO				Fecha: Deposiciones			OBSERVACIONES
	NOMBRE	Edad	Peso	Talla	T.A	F	C		Edad	Peso	Talla	T.A	S	SL	L	
1	Calcina, Eloy	9	32	127.5	36.2	1	N	Sano	9	32.200	127.5	36.2	26	-	-	No hubo aumento de peso Deps. N.
2	Calle, Gabino	7.9	25.8	12.4	36	1	N	Sano	7.9	26	124	36.2	25	-	-	No hay incremento de peso todas Deps. N.
3	Calle, Juan	8	27.100	123.5	36	1	N	Sano	8	27.200	123.5	36.7	12	9	-	No hay incremento de peso-9Dep SL
4	Chávez, Justo	10	29.9	133	36	1	N	Parasitosis	10	30.600	133	36.4	14	1	-	> de peso - 14 Deps. N.
5	Fernandez, Alfonso	9	24	119.5	36.5	1	N	Parasitosis	9	25.200	119.5	36.6	10	6	0	> de peso - 6 Deps. SL
6	Moreira, Luis	10	26.2	130	36.6	2	N	Desnutrición I Parasitosis	10	26.300	130	36.5	14	10	-	No hay incremento de peso 10 Deps. SL
7	Medrano, Roberto	9	26.8	127	36	1	N	Laringitis Parasitosis	9	27.8	127	36	17	2	-	> de peso - 1 vez dolor abdominal durante la noche
8	Maquera, Claudio	7	20.100	106	36.7	1	N	Sano	7	20.400	106	36	25	1	-	> de peso - Desp. N.
9	Medina, Oscar	7	20.700	113.5	36.8	1	N	Teniasis	7	20.800	113.5	36.8	24	2	-	No hay incremento de peso 2 Deps. SL
10	Pilco, Félix	8	24.6	117	36	1	N	Parasitosis	8	24.4	117	36.7	20	-	5	< de peso - 5 Deps. L
11	Sejas, Rómulo	8	21.100	109	36.6	1	N	Parasitosis	8	21.500	109	36.7	24	2	1	> de peso - Deps. N.
12	Santos, Raúl	8	29.9	127.5	36	2	N	Parasitosis	8	29.7	127.5	36.8	23	5	-	< de peso - 5 Deps. SL
13	Sánchez, Roberto	7	19	108	36.5	1	N	Papilomatosis Parasitosis	7	19.8	108	36.6	27	1	-	> de peso - Deps. N.
14	Quispe, Juan	10	29	127	36.7	1	N	Teniasis	10	29.100	127	36.5	17	4	-	No hay aumento de peso Deps. N.
15	Zapata, Roberto	9	28.500	125	36.4	1	N	Teniasis	9	26.700	125	36.7	13	6	-	No hay incremento de peso. Presentó 2 mareos, dolor abdominal 6 Deps. SL

Min. Bienestar Social
Convenio
Min. Industria, Com. y Turs.

PROGRAMA : INTERMINISTERIAL
PROGRAMA DE MEJORAMIENTO NUTRICIONAL A BASE DE PAN DE TRIGO-SOYA-QUINUA
PARA MENORES INTERNOS DE LA CIUDAD DEL NIÑO

	GRUPO AMARILLO Soy/Quinoa Bread	PRE-ESTUDIO				Fecha: Deposiciones		DIAGNOSTICO	POST-ESTUDIO				Fecha: DEPOSICIONES			OBSERVACIONES
	NOMBRE	Edad	Peso	Talla	T.A	F	C		EDAD	Peso	Talla	T.A	S	SL	L	
1	Anibarro, Daniel	9	24.4	120.5	36	I	N	Parasitosis	9	24.5	120.5	36.2	16	7	1	No hubo aumento de peso. 7 Deps. SL - 1 L
2	Anibarro, Edwin	7.9	23.2	114	36.5	I	N	Teniasis	7.9	23.4	114	36	15	11	1	No hubo aumento 11 Deps. SL - 1 L
3	Aruquipa, Mario	9	26.5	125	37	I	N	Teniasis	9	26.9	125	36.5	14	12	-	> de peso - 12 Deps. SL
4	Bustamante, Rolando	9	26	124	36.4	I	N	Sano	9	26.4	124	36.3	7	17	1	Ligero de peso 17 Deps. SL - 1L
5	Balderas, Carlos	7	20.35	117	36.5	2	N	Sano	7	20.7	117	36.7	17	2	8	> de peso - 8 Deps. L
6	Condori, Roberto	8	22.5	117	36	2	N	Sano	8	22.6	117	36.5	19	-	6	No hubo aumento de peso 6 Deps. L
7	Furuya, Fidel	10	29	125	36	I	N	Sano	10	29.2	125	36.5	15	3	.	No hubo aumento de peso Deps. N
8	Gallardo, Jaime	10	28	123	36.3	I	N	Parasitosis	10	29	123	36	19	9	-	> de peso - 9 Deps. SL Dolor abdominal 1 vez
9	Jimenez, Lucio	8	23.85	117	37	2	N	Parasitosis	8	23.6	117	36	25	-	-	< de peso - Deps. N
10	Montalvo, Luis	11	33.2	139	37	2	N	Sano	11	33	139	36	17	9	-	< de peso - 9 Deps. SL
11	Navarro, Pedro	8	21.6	114	36.8	2	N	Sano	8	22.1	114	36.7	18	1	8	> de peso - 8 Deps. L
12	Poma, Sergio	8	23	119.5	36.2	I	N	Papilomatosis Teniasis	8	23	119.5	36.6	21	-	4	No hubo aumento de peso 4 Deps. L
13	Peralta, Marcelino	8	25.6	127	37	2	N	Sano	8	25.8	127	36.5	8	14	2	No hubo aumento de peso 14 Dps. SL
14	Vargas, Leopoldo	7	24.6	116	36	I	N	Parasitosis	7	24.4	116	36.6	21	1	3	< de peso - 3 Deps. L
15	Vera, Rene	9	26.5	124	36.7	I	N	Parasitosis	9	26.3	124	37	15	11	0	< de peso - 11 Deps. SL

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PARA MENORES INTERNOS DE LA CIUDAD DEL NIÑO

	GRUPO VERDE Soy Bread	PRE-ESTUDIO				Fecha: Deposiciones		DIAGNOSTICO	POST-ESTUDIO				Fecha: Deposiciones			OBSERVACIONES
	NOMBRE	Edad	Peso	Talla	T.A	F	C		Edad	Peso	Talla	T.A	S	SL	L	
1	Durán, Félix	8	23.3	116	36	2	N	Papilomatosis Parasitosis	8	23.8	116	36.5	22	-	-	> de peso - Deps. N.
2	Espinoza, Eugenio	10	30.4	132	36.6	1	N	Teniasis	10	31.2	132	36.5	7	15	4	> de peso - 15 Deps SL - 4L
3	Fernandez, Mario	9	24	119	36.5	2	N	Parasitosis	9	24.2	119	36.5	17	3	6	No hubo aumento de peso 6 Deps. L - 3 SL
4	Gutiérrez, Richard	8	22	122	36.7	1	N	Parasitosis	8	22.3	122	36.3	6	19	1	Ligeros > de peso 19 Deps. SL - 1L
5	Gomez, José	7	20.5	113	36.2	1	N	Sano	7	20.6	113	37	16	1	9	No hubo aumento de peso 9 Deps. L - 1 SL
6	Gonzales, Luis	10	27.1	124	36.5	1	N	Parasitosis	10	27.6	124	36.4	8	7	4	Ligero > de peso 7 Deps. SL - 4L
7	Heredia, Eduardo	10	24.5	130	37	1	N	Sano Desnutri. I	10	25.1	130	36	17	8		> de peso - 8 Deps. SL
8	Laruta, Luis	8	24.2	122	37.6	1	N	Sarcoptosis	8	24.2	122	36.6	20	6	1	No hubo aumento de peso 6 Deps. SL - 1 L
9	Montaño, Constantino	7	19.3	106	36.3	1	N	Sano	7	19.6	106	36.6	20	-	-	No hubo aumento de peso Deps. N.
10	Quispe, Martín	8	24.1	117	37	2	N	Sano	8	24.4	117	36.5	16	6	1	Ligero > de peso 6 Deps. SL - 1 L
11	Saravia, Francisco	9	28.4	125	36.2	1	N	Sano	9	29.3	125	36.3	19	2	-	> de peso - 2 Deps. SL
12	Sagárnaga, Francisco	9	23.3	125	36.4	1	N	Parasitosis	9	23.7	125	36.4	11	12	-	> de peso - 12 Deps. SL
13	Tapia, Máximo	9	28.6	121	36.8	1	N	Teniasis	9	29.25	121	36.5	15	12		> de peso - 12 Deps. SL
14	Villegas, Hugo	8.11	20.1	115	36.2	1	N	Impetigo Parasitosis	8.11	20.6	115	36.3	24	-	1	> de peso - Desp. N.
15	Tapia, Sabino	8	25.5	122	36.5	1	N	Sano	8	25.4	122	36.6	19	-	6	< de peso - Deps.

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Primera Semana

GRUPO ROJO NOMBRE	Edad	Peso	Talla	T.A	Deposición N°	S	SL	L
1. Calcina, Eloy	9	32.20	127.5	36.4	N°	7	-	-
2. Calle, Gabino	7.9	26	124	36.4	N°	7	-	-
3. Calle, Juan	8	27.5	123.5	36.4	N°	4	1	-
4. Chavez, Justo	10	29.9	133	36	N°	4	1	-
5. Fernandez, Alfonso	10	25.2	119.5	36.5	N°	5	-	-
6. Moreira, Luis	10	26.4	130	36.2	N°	6	-	-
7. Medrano, Roberto	9	27.350	127	36.2	N°	4	-	-
8. Medina Oscar	7	20.8	113.5	36.2	N°	6	0	0
9. Maquera, Claudio	7	19.850	106	36	N°	6	-	-
10. Pillco, Félix	8	24.8	117	36.5	N°	5	-	-
11. Sejas, Rómulo	8	21.3	109	36.4	N°	6	-	-
12. Santos, Raúl	8	29.5	127.5	36.7	N°	6	1	-
13. Sánchez, Roberto	7	19.5	108	36	N°	7	-	-
14. Quispe, Juan	10	29	127	36	N°	6		-
15. Zapata, Roberto	9	26.7	125	36	N°	4	1	-

Segunda Semana

GRUPO ROJO NOMBRE	Edad	Peso	Talla	T.A	Deposición N°	S	SL	L
1. Calcina, Eloy	9	32.50	127.5	36.4	N°	5	-	-
2. Calle, Gabino	8	25.6	124	36.8	N°	6	-	-
3. Calle, Juan	8	26.7	123.5	36	N°	2	4	-
4. Chavez, Justo	10	30.20	133	36	N°	3	-	-
5. Fernandez, Alfonso	10	25.25	119.5	36.3	N°	4	-	L
6. Moreira, Luis	10	26	130	36.2	N°	3	3	-
7. Medrano, Roberto	9	27	127	36	N°	6	-	-
8. Medina Oscar	7	20.6	113.5	36.6	N°	7	0	0
9. Maquera, Claudio	7	20.100	106	36	N°	6	1	-
10. Pillco, Félix	8	24.5	117	36.8	N°	5	-	2
11. Sejas, Rómulo	8	21.1	109	36.8	N°	5	2	-
12. Santos, Raúl	8	29.8	127.5	36	N°	4	3	-
13. Sánchez, Roberto	7	19.350	108	36	N°	6	1	-
14. Quispe, Juan	10	29	127	36.5	N°	3	3	-
15. Zapata, Roberto	9	26.8	125	36.5	N°	3	3	-

Tercera Semana

GRUPO ROJO NOMBRE	Edad	Peso	Talla	T.A	Deposición N°	S	SL	L
1. Calcina, Eloy	9	31.8	127.5	36.5	N°	7	-	-
2. Calle, Gabino	8	25.6	124	36.5	N°	5	-	-
3. Calle, Juan	8	27.1	123.5	36	N°	1	-	-
4. Chavez, Justo	10	30	133	36.5	N°	4	-	-
5. Fernandez, Alfonso	10	25.20	119.5	36	N°	8	4	0
6. Moreira, Luis	10	26	130	36.5	N°	4	3	-
7. Medrano, Roberto	9	27	127	36	N°	4	2	-
8. Medina Oscar	7	20.800	113.5	36	N°	7	0	0
9. Maquera, Claudio	7	20	106	36	N°	6	-	-
10. Pillco, Félix	8	24.500	117	36	N°	6	-	-
11. Sejas, Rómulo	8	21	109	36.5	N°	7	-	-
12. Santos, Raúl	8	29.9	127.5	36.6	N°	6	1	-
13. Sánchez, Roberto	7	19.500	108	36.2	N°	7	-	-
14. Quispe, Juan	10	28.9	127	36.5	N°	5	1	-
15. Zapata, Roberto	9	26.5	125	36	N°	3	1	-

Cuarta Semana

GRUPO ROJO NOMBRE	Edad	Peso	Talla	T.A	Deposición N°	S	SL	L
1. Calcina, Eloy	9	32.15	127.5	36.8	N°	7	-	-
2. Calle, Gabino	8	25.85	124	36.5	N°	7	-	-
3. Calle, Juan	8	27	123.5	36	N°	3	3	-
4. Chavez, Justo	10	30.15	133	36.2	N°	3	-	-
5. Fernandez, Alfonso	10	25.200	119.5	36	N°	1	2	0
6. Moreira, Luis	10	26.300	130	36.8	N°	3	4	-
7. Medrano, Roberto	9	27.50	127	36.2	N°	3	-	-
8. Medina Oscar	7	20.800	113.5	36.5	N°	5	2	0
9. Maquera, Claudio	7	20.400	106	36	N°	7	-	-
10. Pillco, Félix	8	24.750	117	36	N°	4	-	3
11. Sejas, Rómulo	8	21.6	109	36	N°	6	-	1
12. Santos, Raúl	8	29.500	127.5	36.8	N°	7	-	-
13. Sánchez, Roberto	7	19.55	108	36	N°	7	-	-
14. Quispe, Juan	10	28.9	127	36.5	N°	3	-	-
15. Zapata, Roberto	9	26.9	125	36	N°	3	1	-

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GRUPO AMARILLO NOMBRE	Primera Semana								Segunda Semana								Tercera Semana								Cuarta Semana							
	Edad	Peso	Talla	T.A	Deposición N°	S	SL	L	Edad	Peso	Talla	T.A	Deposición N°	S	SL	L	Edad	Peso	Talla	T.A	Deposición N°	S	SL	L	Edad	Peso	Talla	T.A	Deposición N°	S	SL	L
1. Anibarro, Daniel	9	24.8	120.5	36.8	N°	4		-	9	24.8	120.5	36.7	N°	4	2	1	9	24.4	120.5	36.7	N°	4	3	-	9	24.20	120.5	36.4	N°	2	4	-
2. Anibarro, Edwin	7.9	23.6	114	36	N°	6	-	-	7.9	23.1	114	36.7	N°	4	3	-	7.9	23.15	114	36	N°	1	6	-	7.9	23.55	114	36	N°	4	2	1
3. Aruquipa, Mario	9	26.7	125	36.2	N°	3	2	-	9	26.7	125	36.8	N°	4	3	-	9	26.5	125	36.5	N°	5	2	-	9	26.7	125	36.4	N°	2	-	5
4. Bustamante, Rolando	9	26.3	124	36	N°	5	-	-	9	26.2	124	36	N°	1	4	1	9	26	124	36	N°	1	6	-	9	26.3	124	36	N°	-	7	-
5. Balderas, Carlos	7	20.5	117	36.5	N°	3	1	2	7	20.3	117	36.2	N°	4	-	3	7	20.3	117	36.5	N°	7	-	-	7	20.4	117	36.5	N°	3	1	3
6. Condori, Roberto	8	22.3	117	36.2	N°	5	-	-	8	22.3	117	36.8	N°	5	-	1	8	22	117	36.5	N°	7	-	-	8	22.1	117	36.5	N°	2	-	5
7. Furuya, Fidel	10	28.7	125	36.5	N°	3	-	-	10	29	125	36	N°	4	1	-	10	28.75	125	36.3	N°	3	2	-	10	29.2	125	36.2	N°	5	-	-
8. Gallardo, Jaime	10	28.7	123	36	N°	6	1	-	10	28.8	123	36.6	N°	4	3		10	28.5	123	36	N°	4	3	-	10	28.7	123	36	N°	5	2	-
9. Jimenez, Lucio	8	23.6	117	36	N°	5	-	-	8	23.1	117	36	N°	7	-	-	8	23.3	117	36	N°	6	-	-	8	23.55	117	36	N°	7	-	-
10. Montalvo, Luis	11	32.5	139	36.6	N°	6	1	-	11	33	139	36.2	N°	3	3	-	11	32.8	1399	36	N°	3	4	-	11	32.6	139	36.3	N°	6	1	-
11. Navarro, Pedro	8	22	114	36.8	N°	7	-	-	8	21.15	114	37	N°	3	1	3	8	21.45	114	36	N°	3	-	4	8	21.8	114	36.5	N°	6	-	1
12. Pome, Sergio	8	22.75	119.5	36.3	N°	4	-	2	8	23.2	119.5	36.8	N°	7	-	-	8	22.75	119.5	36.5	N°	5	-	1	8	23	119.5	36	N°	5	-	1
13. Peralta, Marcelino	8	25.5	127	36.3	N°	2	4	1	8	26	127	36.4	N°	3	-	1	8	25.4	127	36.3	N°	-	7	-	8	25.4	127	36.3	N°	3	4	-
14. Vera, René	9	26.25	124	37	N°	5	1	-	9	26.3	124	36.2	N°	3	4	-	9	26	124	36.5	N°	2	4	-	9	26.3	124	36.9	N°	5	2	-
15. Vargas, Leopoldo	7	24.9	116	36	N°	5	1	-	7	24.45	116	37	N°	7	-	-	7	24.4	116	36.5	N°	5	-	2	7	24.8	116	36.5	N°	5	-	1

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GRUPO VERDE	Primera Semana								Segunda Semana							
					Deposición								Deposición			
N O M B R E	Edad	Peso	Talla	T.A	N°	S	SL	L	Edad	Peso	Talla	T.A	N°	S	SL	L
1. Durán, Félix	8	24.1	116	36.6	N°	6	-	-	8	23.9	116	36.5	N°	6	-	-
2. Espinoza, Eugenio	10	30.35	132	36.6	N°	-	1	2	10	30.5	132	36	N°	-	5	2
3. Fernandez, Mario	9	24.35	119	36.3	N°	4	1	2	9	24.1	119	36.5	N°	6	-	1
4. Gutiérrez, Richard	8	22.15	122	36.4	N°	5		-	8	22.2	122	36.4	N°	-	6	1
5. Gomez, José	7	20.35	113	36.5	N°	6	-	1	7	20.6	113	36.5	N°	6	-	1
6. Gonzales, Luis	10	27.6	124	36.5	N°	4	-	1	10	27.5	124	36.3	N°	2	1	1
7. Heredia, Eduardo	10	24.5	130	36.8	N°	5	1	-	10	24.55	130	36	N°	3	4	-
8. Laruta, Luis	8	24.1	122	36.8	N°	6	-	-	8	24	122	36.7	N°	3	3	1
9. Montaño, Constantino	7	19.4	106	36.8	N°	5	-	-	7	19.85	106	36	N°	5	-	-
10. Quispe, Martín	8	24.5	117	36.8	N°	5	1	-	8	24.4	117	36.7	N°	2	3	-
11. Saravia, Francisco	9	28.6	125	36	N°	7	-	-	9	28.7	125	36	N°	2	2	-
12. Sagarnaga, Francisco	9	26.3	125	36	N°	5	1	-	9	26.5	125	36	N°	3	1	-
13. Tapia, Máximo	9	28.8	121	36.2	N°	5	2	-	9	29	121	36.4	N°	4	3	-
14. Villegas, Hugo	6.11	20.6	115	36.8	N°	5	-	-	6.11	20.25	115	36.5	N°	7	-	-
15. Zeballos, Sabino	8	25.7	122	36.5	N°	4	-	2	8	25.5	122	36.5	N°	7	-	-

GRUPO VERDE	Tercera Semana								Cuarta Semana							
					Deposición								Deposición			
N O M B R E	Edad	Peso	Talla	T.A	N°	S	SL	L	Edad	Peso	Talla	T.A	N°	S	SL	L
1. Durán, Félix	8	23.85	116	36.2	N°	4	-	-	8	23.8	116	36.6	N°	6	-	-
2. Espinoza, Eugenio	10	30.3	132	36	N°	2	5	-	10	30.6	132	36.3	N°	2	[illegible]	-
3. Fernandez, Mario	9	24.3	119	36.5	N°	4	1	1	9	24.2	119	36.5	N°	3	2	1
4. Gutiérrez, Richard	8	21.9	122	36.8	N°	-	7	-	8	22.1	122	36.7	N°	1	6	-
5. Gomez, José	7	20.4	113	36	N°	4	-	3	7	20.7	113	36	N°	-	1	4
6. Gonzales, Luis	10	27.45	124	36	N°	2	4	-	10	27.4	124	36	N°	-	3	1
7. Heredia, Eduardo	10	24.6	130	36.2	N°	6	1	-	10	25	130	36.5	N°	3	2	-
8. Laruta, Luis	8	23.7	122	36.8	N°	5	2	-	8	24	122	36.5	N°	6	1	-
9. Montaño, Constantino	7	19.5	106	36	N°	5	-	-	7	19.6	106	36.2	N°	5	-	-
10. Quispe, Martín	8	24.4	117	36.9	N°	3	2	1	8	24.6	117	36.8	N°	6	-	-
11. Saravia, Francisco	9	28.7	125	36	N°	6	-	-	9	29.05	125	36.3	N°	4	-	-
12. Sagarnaga, Francisco	9	26.2	125	36.8	N°	1	5	-	9	26.6	125	36	N°	2	5	-
13. Tapia, Máximo	9	28.85	121	36	N°	6	1	-	9	29.1	121	36.3	N°	-	6	-
14. Villegas, Hugo	6.11	20.2	115	36.3	N°	6	-	-	6.11	20.3	115	36	N°	6	-	1
15. Zeballos, Sabino	8	25.6	122	36	N°	5	-	2	8	25.4	122	36.5	N°	3	-	2

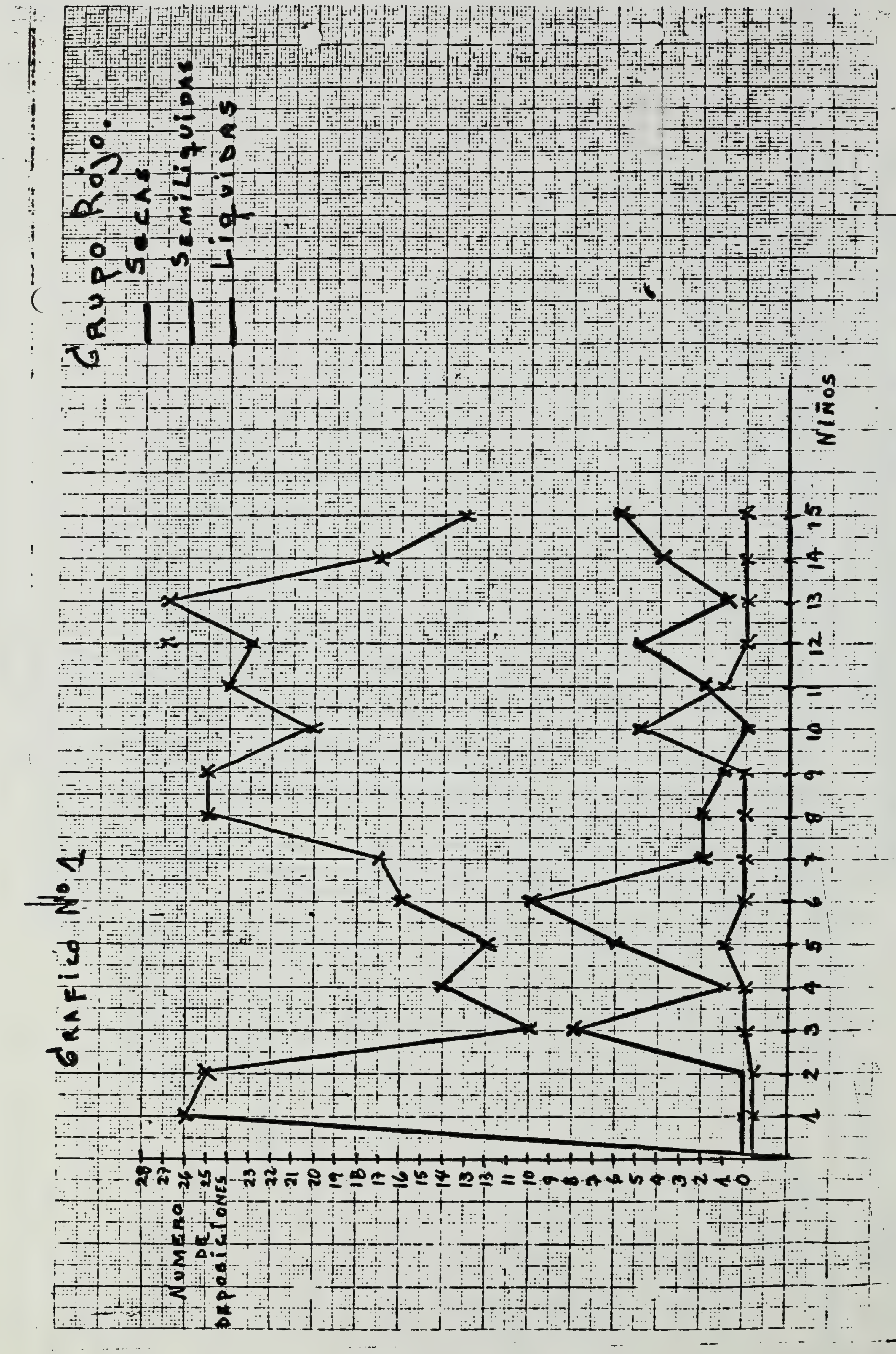


GRAFICO No 1
GRUPO ROJO
SECAS
SEMILIQUIDAS
LIQUIDAS
NUMERO DE DEPOSICIONES
NIÑOS

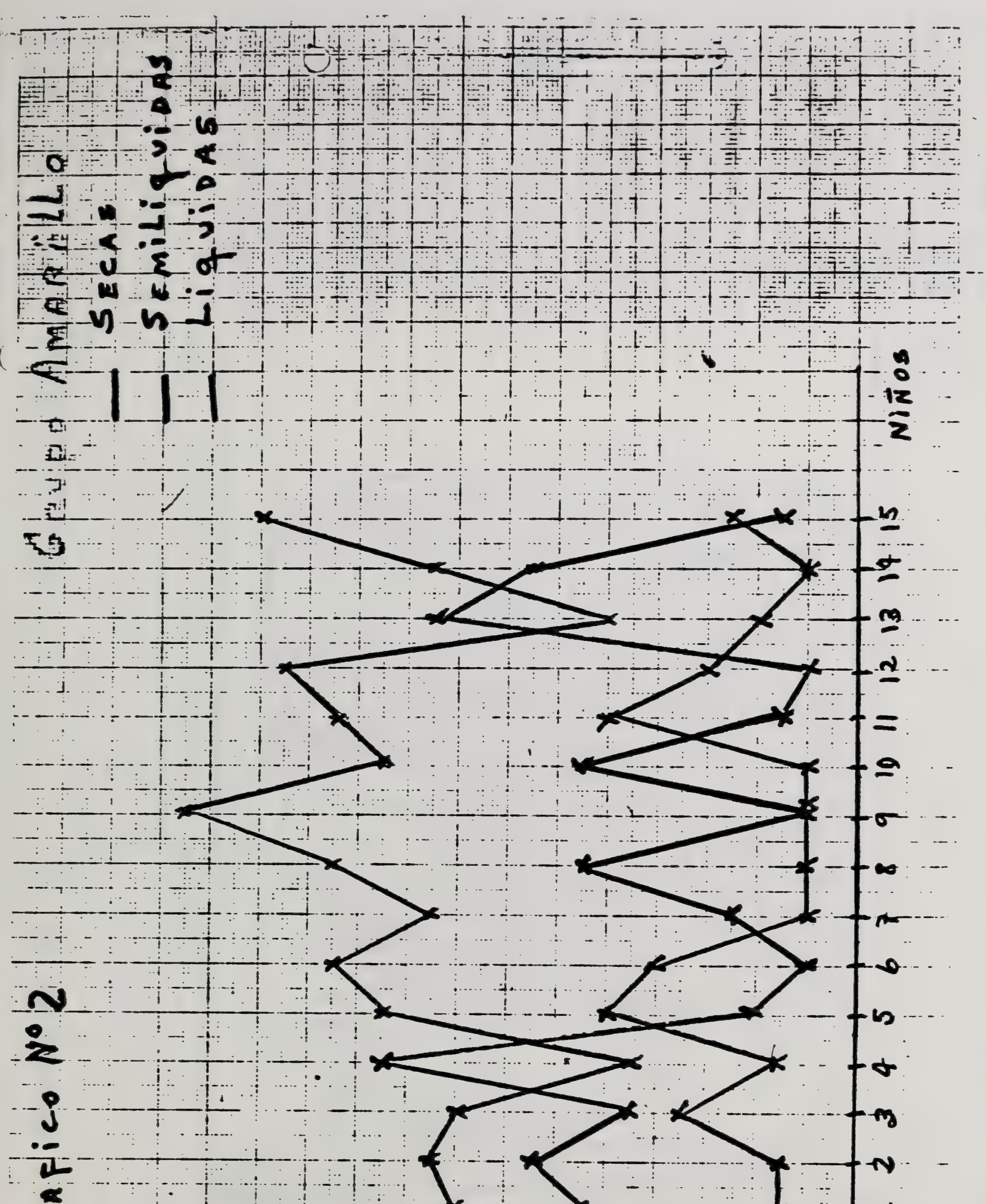
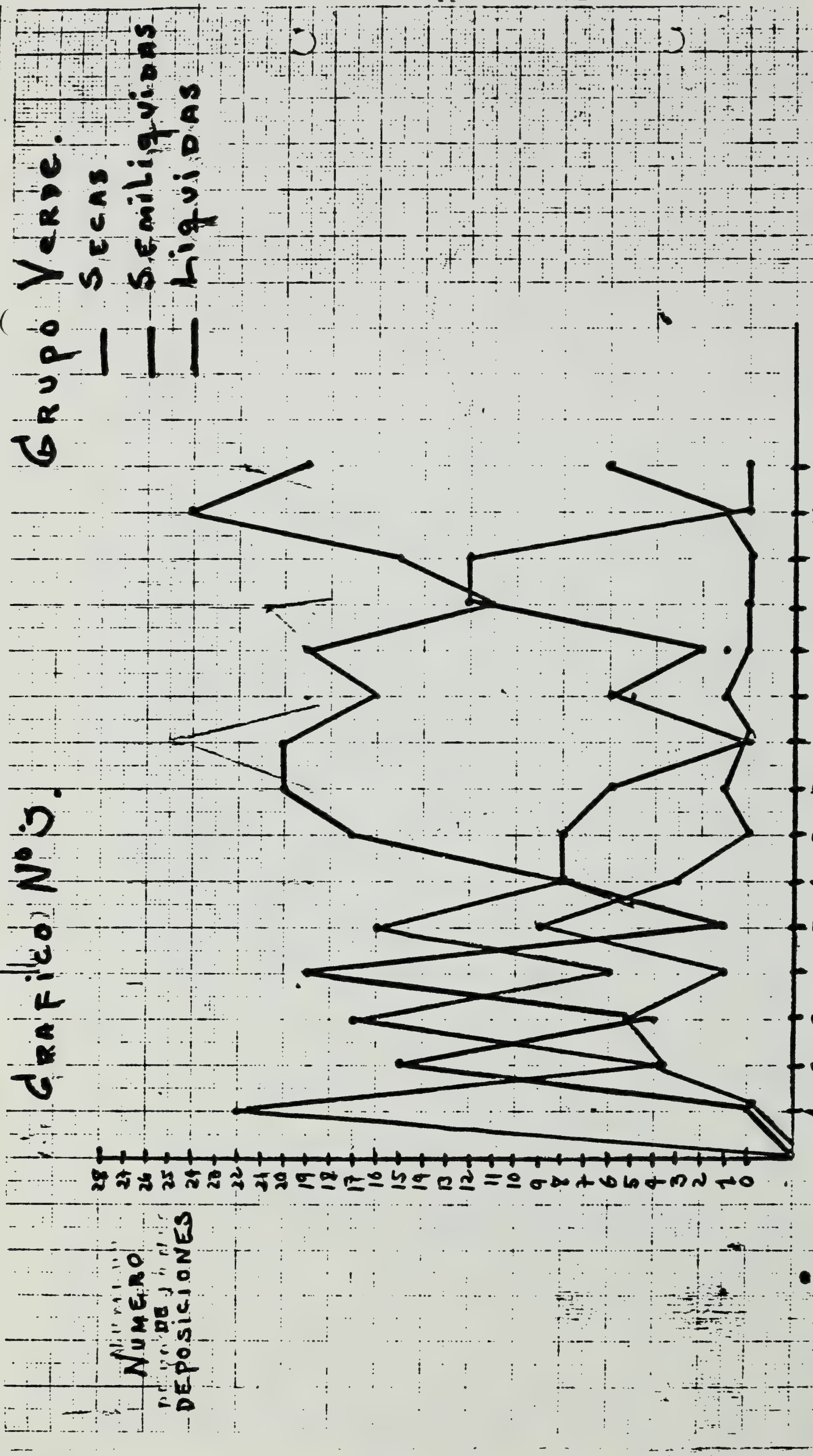


GRAFICO N° 2
Grupo Amarillo
SECAS
SEMILIQUIDAS
LIQUIDAS
NUMERO DE DEPOSICIONES
NIÑOS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GRUPO VERDE.
SECAS
SEMILIQUIDAS
LIQUIDAS
NUMERO DE DEPOSICIONES
NIÑOS
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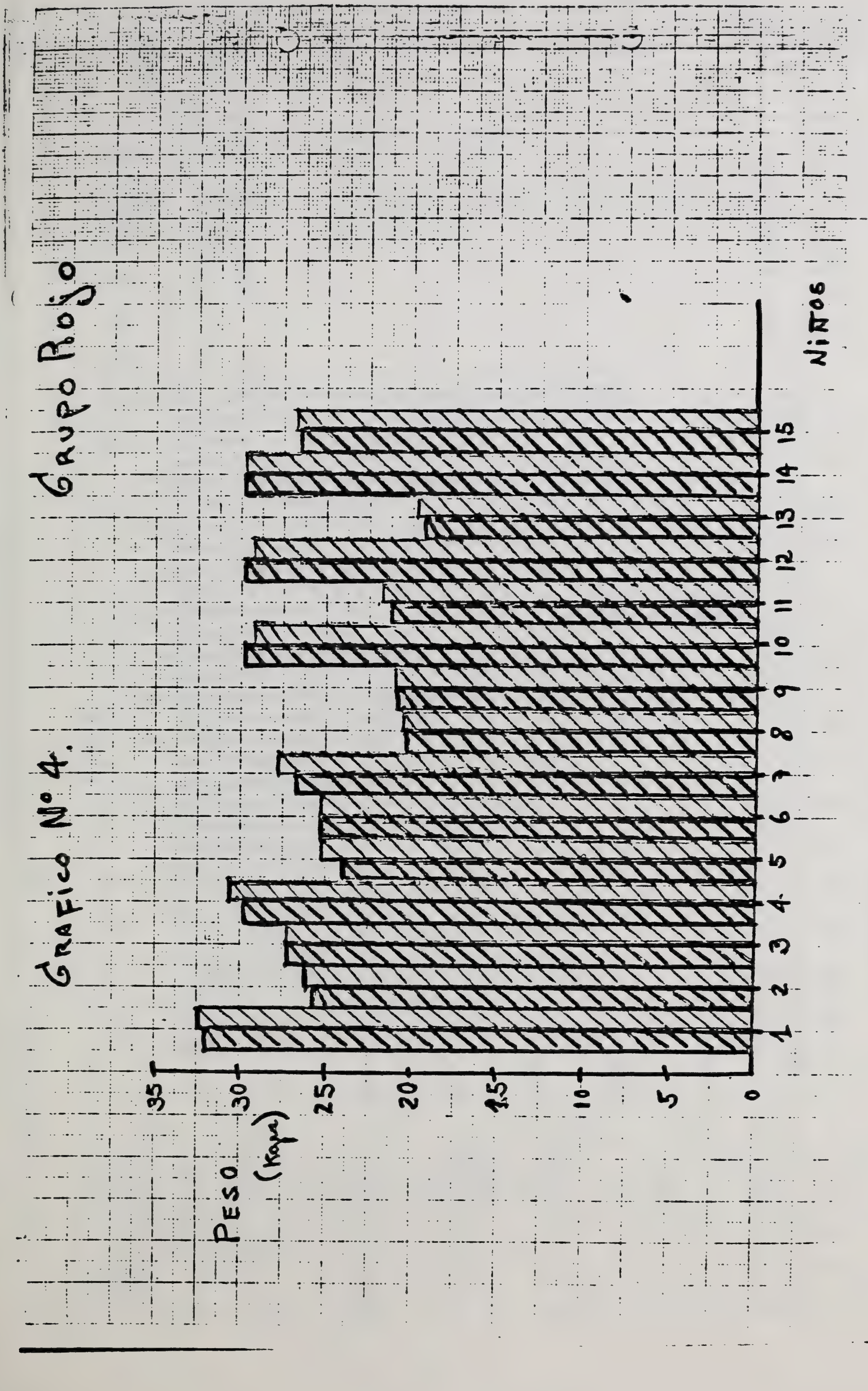
Grafico Nº 4.
Grupo Rojo
Peso (Kgs)
Niños
0
5
10
15
20
25
30
35
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

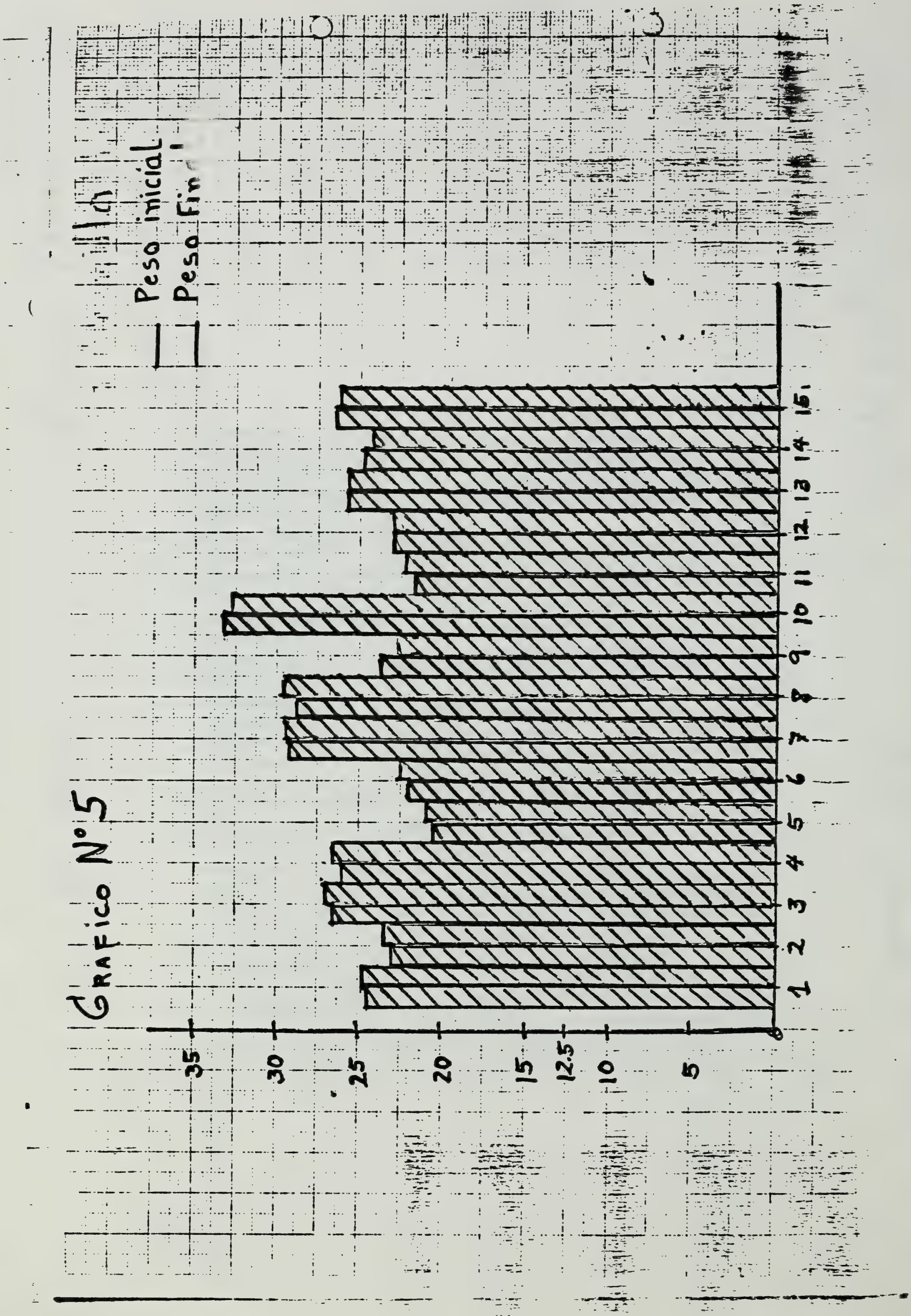
Grafico N°5
Peso inicial
Peso Fin
35
30
25
20
15
12.5
10
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1
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5
6
7
8
9
10
11
12
13
14
15

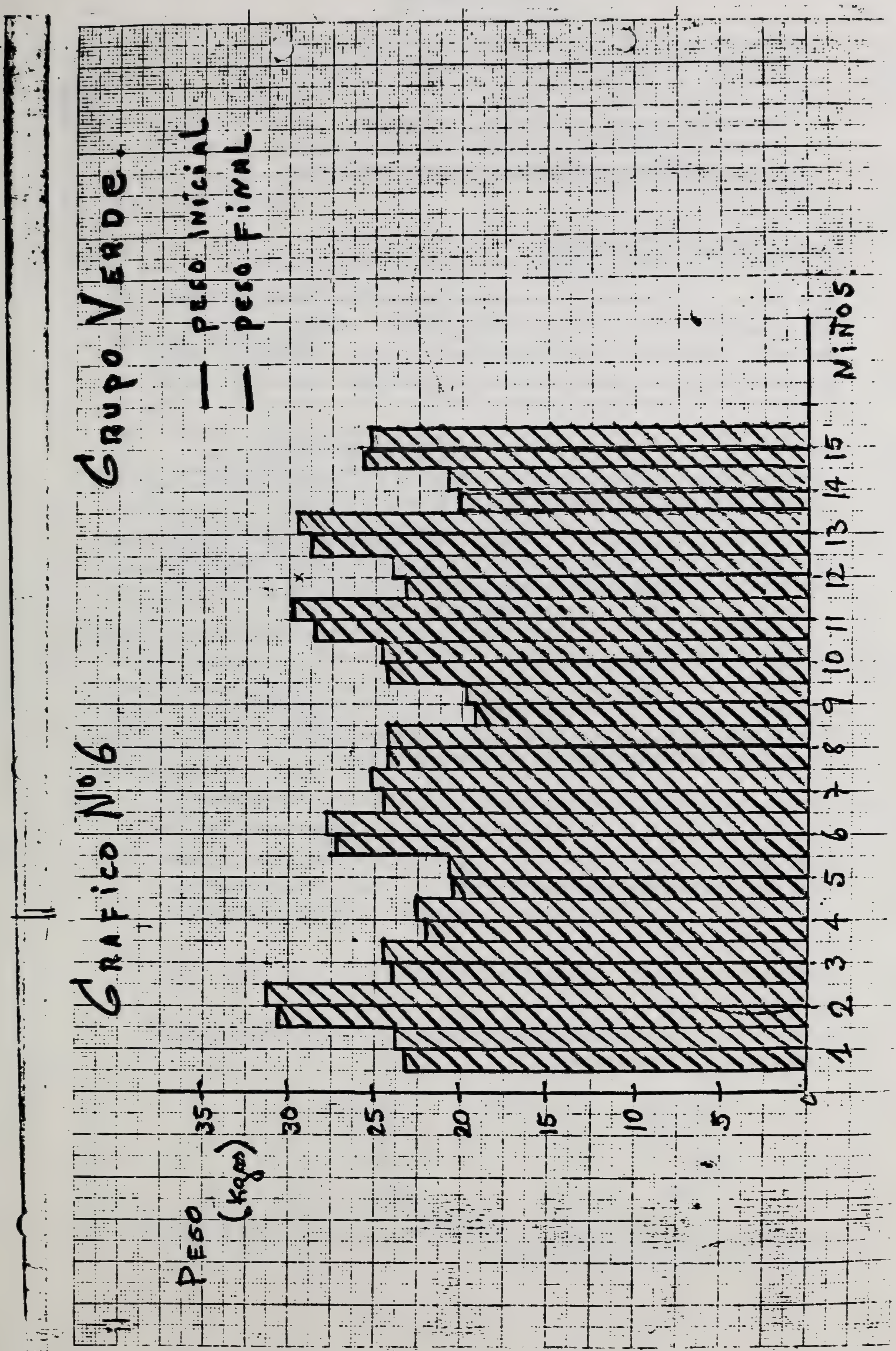


GRAFICO No 6
GRUPO VERDE.
PESO INICIAL
PESO FINAL
PESO
(Kgm)
35
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
NIÑOS.

INFORME NUTRICIONAL

PRUEBA DE ACEPTACION Y TOLERANCIA A LOS TRES TIPOS DE PAN

1.- ESTUDIO PRELIMINAR A LA PRUEBA.

Tuvo por finalidad observar las manifestaciones del niño hacia la alimentación proporcionada por el hogar, así como apetito, tolerancia o rechazo y mas aún manifestaciones gastrointestinales tales como: flatulencia, tipo y frecuencia de deposiciones por día, por lo que se pudo observar lo siguiente:

a) La mayoría de los niños en estudio estaban aparentemente sanos.
b) Se pudo observar la aceptación a los cuatro tiempos de comida; desayuno, almuerzo, te y cena proporcionada como alimentación habitual.
c) Todos los niños tienen buen apetito y no presentaban manifestaciones gastrointestinales que pudieran ser tomadas encuenta como anormales, pero sí, fué necesario observar el estreñimiento en la mayoría de los casos ya que las deposiciones fueron con el lapso de 3 o 4 días.

2.- APLICACION DE LA INVESTIGACION.

a) Muestra.- Se inicio en 45 niños previamente reconocidos como sanos, estos fueron distribuidos en tres grupos (rojo, amarillo y verde) cuyas edades en cada grupo oscilaban entre los 6 y 9 años de edad.

b) Para el desarrollo de la prueba de tolerancia al pan, se confeccionaron cuatro menús semanales los cuales estaban adecuados cuantitativa y cualitativamente. En dichos menús se cubrieron las calorias requeridas y recomendadas por el Departamento del Nutrición del Ministerio de Salud Pública, por lo que la alimentación en general proporcionó 2,500 Kcal/persona/día y 65 gramos de proteína/persona/día.
Hubo muy poco cambio y en su mayoría se mantuvo lo menús habituales proporcionados en la Ciudad del niño.

c) El pan consumido por los tres grupos en estudio fué de tres unidades diarías distribuidos de la siguiente manera:

Desayuno	1	unidad	=	80	gramos
Almuerzo	½	"	=	40	"
Te	1	"	=	80	"
Cena	½	"	=	40	"

Estas tres unidades o 240 gramos proporcionó en promedio 636 Kcal/persona/día y 22.5 gramos de proteína/persona/día.

d) La distribución del pan se hizo por grupos, primero el rojo, luego el amarillo y posteriormente el verde, teniendo mucho cuidado que cada niño asignado en cada grupo recibiera en forma individual de la canasta al color que le correspondía.

e) Cada grupo tuvo su respectiva mesa desde el inicio hasta la conslusión de la prueba, se hizo con la finalidad de tener un mayor control de la cantidad de pan consumido por niño.

RESULTADO Y CONSLUSION.

a) Al cabo de los 28 días se concluyó con el estudio, en el lapso de este tiempo la administración del pan se interrumpió en dos tiempos de comida; una vez en el desayuno y otra en la cena.

b) Se pudo ver buena aceptación y tolerancia al pan en los tres grupos de niños en estudio, tanto es así que el consumo de tres unidades por día fué del 94% de los casos y el 6% consumió entre dos y medio y dos por día. Este porcentaje mínimo no es que rechazó el tipo de pan, sinó que comian bocadillo antes del almuerzo o otros por lo regular no apetecian pan.

c) No se observó ninguna manifestación gastrointestinal, aún en los días que el menú contemplaba alimentos de Caritas y preparaciones con quinua, lo que nos demuestra que el pan es muy bien tolerado con cualquier tipo de dieta.

d) El aporte proteínico del pan fué alto, pero no se pudo observar un aumento de peso considerable por lo corto del tiempo en estudio.

Lic. Sofia Bueno L.

CIUDAD DEL NIÑO

MENU SEMANAL 1

HRS		MARTES	MIERCOLES	JUEVES	VIERNES	SABADO	DOMINGO	LUNES
9:00	DESAYUNO	- Apia - Pan	- Café con leche - Pan	- Café - Pan y - Queso	- Cocoa con leche - Pan	- Café - Pan y - Queso	- Api - Pan	- Avena con leche - Pan
10:30	M. M.	- Lima	- Plátano.	- Durazno	- Durazno	- Platano	- Gelatina	- Pito con azucar
12:30	ALMUERZO	- Lawa de Choclo - Tallarín - Pan - Refresco	- Sopa Maní - Ensalada de lechuga con hamburguesa y postre - Pan - Refresco	- Sopa Acelga - Guiso de carne con fideo - Pan - Refresco	- Sopa Quinua - Plato Paceño - Pan - Refresco	- Sopa Zapallo - Arroz a la valenciana - Pan - Leche	- Sopa Fideo - Fricasé - Pan - Refresco	- Sopa Chairo. - Ensalada de beterraga con papa y asado - Pan - Refresco
16:00	TE	- Te - Pan	- Te - Pan	- Te - Pan	- Te - Pan	- Te - Pan	- Te - Pan	- Te - Pan
18:00	CENA	- Albondigas con arroz - Pan	- Saice con puty de turta y papa - Pan	- Jakonta - Leche - Pan	- Ensalada mixta con asado - Pan	- Puré de papa con milaneza - Pan	- Pastel de arroz - Pan	- Tomatada de carne con fideo - Pan

....

Fecha: del 4 al 10 de marzo de 19

CIUDAD DEL NIÑO

MENU SEMANAL 2

HORA		MARTES	MIERCOLES	JUEVES	VIERNES	SABADO	DOMINGO	LUNES
9:00	DESAYUNO	- Maizena con leche - pan	- Chocolate con leche - Pan	- Café con - Pan y - Queso	- Café con leche - Pan	- Avena con leche - Pan	- Api con - Pan	- Café con leche - Pan
10:30	M. M.	- Lima	- Plátano	- Durazno	- Durazno	- Membrillo	- Plátano	- Leche
12:30	ALMUERZO	- Sopa Acelga - Plato cubano - Pan - Refresco	- Sopa Chaque de trigo - Enselada de lechuga c/hígado epanado y camote - Pan - Refresco	- Sopa Repollo - Tomatada de fideo con postre - Pan - Refresco	- Sopa Sémola - Carbonada de zapallo con arroz - Pan - Refresco	- Sopa Choclo - Ranga - Ranga con sarza - Pan - Refresco	- Sopa Fideo - Ensalada Mixta con asado - Pan - Refresco	- Sopa Chairo - Tallarín - Pan - Refresco
16:00	TE	- Te - Pan	- Te - Pan	- Te - Pan	- Te - Pan	- Te - Pan	- Te - Pan	- Te - Pan
18:00	CENA	- Asado en olla con papas - Pan	- Queso humacha con choclo - Pan	- Puré de papa con hambur - guesa - Pan	- Enselada de racacha con asado - Pan	- Arroz a la valenciana - Pan	- Api de trigo - Pan	- Jakonta - leche - Pan

OBSERVACION.............................. .. ..

Fecha: del 11 al 17 de marzo de 1980

Edificio
Lotería Nacional
4to., 5to., y 6to. Pisos
Casilla 4307 - 476

MINISTERIO DE BIENESTAR SOCIAL

Teléfonos:
376862 . 376863
376864 - 376865 - 376866
La Paz — Bolivia

J.M.N. 016/80

La Paz, 10 de Abril de 1.980

Señora
Lic. Elba Ojara de Jemio
MINISTRO DE BIENESTAR SOCIAL Y FAMILIA
Presente.-

REF: INFORME DE TRABAJO

Exma. Señora Ministro:

Con la presente adjunto a Ud. el informe del trabajo realizado dentro del convenio con el Ministerio de Industria Comercio y Turismo, en cuanto a la Aceptación Fisiológica del pan de trigo, soya y quinua, dentro del Proyecto de Mejoramiento Nutricional de Alimentos a base de Harina de Trigo, realizado en menores de la Ciudad del Niño.

Sin otro particular, saludo a Ud. muy Atentamente.

c.c. J.M.N.
c.c. Min. de Industria
c.c. Archivo

Edificio
Lotería Nacional
4to., 5to., y 6to. Pisos
Casilla 4307 - 476

MINISTERIO DE BIENESTAR SOCIAL

Teléfonos:
376862 - 376863
376864 - 376865 - 376866
La Paz — Bolivia

"AÑO DE LA HEROINA JUANA AZURDUY DE PADILLA"

3 JUL. 1980

La Paz, 2 de Julio 1980
DM/348/80

Junta Nacional de Accion Social
COORDINACION
REGISTRO Y ARCHIVO GRAL.
No. DE SALIDA 003240
FECHA 3 JUL. 1980

Señor
Lic. Juán Carlos Navajas Mogro
MINISTRO DE INDUSTRIA, COMERCIO
Y TURISMO
Presente

Señor Ministro:

Doy respuesta a su atento Oficio DGNT-T-C- 210/80, fechado el 18 del mes en curso, relacionado con el Proyecto "Mejoramiento Nutricional de los Alimentos a Base de Harina de Trigo - Pruebas de Aceptación Fisiológica".

Informar sobre elaboración del plan

Estoy de acuerdo en que el Ministerio de Bienestar Social, participe dentro de las actividades fijadas en el Plan de Implementación, encontrandonos a a la espera del mencionado plan de trabajo y la fecha de la primera reunión.

Con referencia a la donación que realizará el Ministerio a su cargo, de 150 tazas de fierro enlozado, agradezco a usted por el importante donativo el que será distribuido para el desayuno y te de los niños que se albergan en la Ciudad del Niño.

Asimismo, adjunto a la presente el informe médico solicitado.

Con éste motivo, saludo a usted señor Ministro con mis consideraciones distinguidas.

Elba de Jemio

Lic. Elba Ojara de Jemio
MINISTRO DE ESTADO ENCARGADO
DE LA JUNTA NAL. DE ACCION SOCIAL

Adj: File Informe Médico
/hqn.

MINISTERIO DE INDUSTRIA, COMERCIO Y TURISMO
DIRECCIÓN GENERAL DE NORMAS Y TECNOLOGIA (DGNT)
WESTERN REGIONAL RESEARCH CENTER (EE UU - WRRC)

SEMINARIO: "MEJORAMIENTO NUTRICIONAL DE LOS ALIMENTOS A BASE DE HARINA DE TRIGO"

La Paz, 22 al 24 de Agosto 1979

PROGRAMA

SESION INAUGURAL: MIERCOLES 22

9h30 a 10h30 — 1 ACTO DE INAUGURACION

1.1 Palabras a cargo del Director General de Normas y Tecnología (DGNT)

1.2 Palabras a cargo del Dr. David Fellers del Western Regional Research Center (WRRC) Departamento de - Agricultura de los Estados Unidos de Norte América

1.3 Inauguración Oficial del Seminario a cargo del Sr. Ministro de Industria, Comercio y Turismo (MICT).

1.4 Entrega de carpetas y material de trabajo a los delegados y participantes.

PRIMERA SESION: MIERCOLES 22

10h45 a 12h00 — 2 PRESENTACION DEL PROYECTO "MEJORAMIENTO NUTRICIONAL DE LOS ALIMENTOS A BASE DE HARINA DE TRIGO"

2.1 Antecedentes

2.2 Descripción

2.3 Justificación (Aspectos económicos, sociales y técnicos)

2.4 Participación de Sectores (Investigativo, productivo y Gubernamental)

2.5 Resultados

Presentación a cargo de: Ing. Gregorio Bernal Yáñez
Director General de Normas y Tecnología.

Ing. Roberto Espinoza G.
Jefe Técnico del Proyecto

SEGUNDA SESION: MIERCOLES 22

14h30 a 15h45 — 3 ASPECTOS SOCIO ECONOMICOS DE LA POBLACION BOLIVIANA

3.1 Situación Alimentaria y nutricional de Bolivia

.2 Factores determinantes del problema

3.3 Políticas alimentarias y nutricionales del país

Presentación a cargo de: Instituto Nacional de Alimentación y Nutrición (INAN) Min. de Planeamiento y Coordinación

D. Gonzalo Fernández

3.4 Discusión

Refrigerio

15h45 a 16h15 4 POTENCIAL DE ALIMENTOS PARA ENCARAR LOS PROBLEMAS DE NUTRICION EN BOLIVIA

Presentación a cargo de: Dra. Antoniette Betschart
Nutricionista WRRC - EE UU

Dra. Jean Wight
Jefe de Oficina de Nutrición
USAID - Bolivia

Discusión

TERCERA SESION: JUEVES 23

9h00 a 9h30 5 MATERIAS PRIMAS CONSIDERADAS PARA EL DESARROLLO DEL PROYECTO

Presentación a cargo de: Ing. Roberto Espinoza G.
Jefe Técnico del Proyecto
(DGNT)

9h30 a 10h00 5.1 Arroz

a) Características Generales
b) Situación actual su potencial
c) Usos - Clasificación
d) Alternativas tecnológicas

Presentación a cargo de: Ing. Raúl Chavez L.
Técnico del Proyecto

10h00 a 10h30 5.2 Quínua

a) Características Generales
b) Situación actual y potencial
c) Usos
d) Estudios anteriores
e) Alternativas tecnológicas para su industrialización

	Presentación a cargo de:	Ing. Roberto Espinoza G. Jefe Técnico del Proyecto
10h30 a 10h45	Refrigerio	
10h45 a 11h05	5.3 Soya	

a) Características

b) Soya y la nutrición

c) Soya de harinas compuestas

d) Inhibidor tripsina

e) Alternativas tecnológicas para su industrialización y usos

Presentación a cargo de: DGNT

11h05 a 11h25 — 5,4 Estudios y planes para producir HARINA DE SOYA PARA CONSUMO HUMANO

Presentación a cargo de: Sociedad Aceitera del Oriente (SAO)

11h25 a 11h50 — 5.5 Potencial y costos para la producción de harina de soya en Bolivia

Presentación a cargo de: Lic. Robert Enochian
Economista WRRC

11h50 a 12h10 — 5.6 Maíz

a) Aspectos Generales

b) Proyecto de Mairana "CORDECRUZ"

Presentación a cargo de: NUTRINAL
CORDECRUZ

Discusión

15h00 a 16h30 — 6 VISITA A LABORATORIOS DGNT

CUARTA SESION: VIERNES 24

9h00 a 10h00 — 7 FACTIBILIDAD TECNICA PARA LA ELABORACION Y APROVECHAMIENTO DE HARINAS COMPUESTAS

7.1 Técnicas empleadas en laboratorio e industria para la preparación de harinas de Arroz, Soya, Quínua, Trigo, Maíz - Harinas Compuestas

7.2 Características químicas nutricionales y reológicas de las harinas

	Presentación a cargo de: DGNT y Maura Beans del WRRC
10h00 a 10h20	Discusión
	Refrigerio
10h20 a 12h00	7.3 Pruebas de panificación en laboratorio e industria
	7.4 Pruebas de elaboración de pastas alimenticias en laboratorio
	7.5 Programas a desarrollar para la finalización del proyecto
	7.6 Conclusiones
	Presentación a cargo de: DGNT y Maura Beans (WRRC) Especialista en Tecnología de Alimentos
18h00	8. <u>CLAUSURA</u>
	8.1 Resumen de las principales Conclusiones y Recomendaciones del Seminario
	8.2 Entrega de Certificados a Participantes
	8.3 Palabras de clausura a cargo del señor Ministro de Industria, Comercio y Turismo.
	8.4 Cocktail

CONCLUSIONS AND RECOMMENDATIONS OF THE SEMINAR "IMPROVING THE NUTRITIONAL VALUE OF WHEAT FOODS"

August 22-24, 1979; La Paz, Bolivia

Taking into consideration that:

1. The Project, "Improving the Nutritional Value of Wheat Foods" has demonstrated in its first phase the technical feasibility for making composite flours with wheat, corn, quinoa, soy and rice and the production of bread and other foodstuffs with high protein content from them.

2. The project requires additional and colateral activities to be taken, such as the increased development of agriculture and agribusiness.

3. The project requires the full cooperation of all Bolivians in both the public and private sectors at all socio-economic levels.

4. Research is an integral part of increasing productivity.

5. The implementation of the project at the national level will require an adequate commercialization policy which will guaranty the existence of the current and new agroindustrial activity.

6. The solution of food and nutrition problems must be through a coordinated, multisectoral program.

Then it is apparent that:

- the agriculture policy of the country must be directed to increase the cultivation of cereals (wheat, corn, soy, quinoa and rice) and improving yields. This should be accomplished by selection of adequate seeds by the Ministry of Agriculture and Campesino Affairs in coordination with the Ministry of Industry, Commerce and Tourism (MICT). Coordination with MICT is important because of their responsibilities in commercialization of agricultural crops.

- the institutions related to the education activity must concentrate their efforts to encourage Bolivians to maximize use of national resources to the benefit of national development and improved nutrition.

- on their part, the institutions dedicated to basic and applied research must coordinate their tasks towards advancement of the project itself and its derivatives (case of tarhui), so that low-cost flour industrialization may take place which will lead to overcoming malnutrition and dependency problems.

Based on the general considerations and conclusions above mentioned, the participants of the seminar "Improving the Nutritional Value of Wheat Foods" recommend to the sponsoring institutions specifically, and in general to all institutions, directly or indirectly involved in the project, the implementation of the following recommendations:

1. The government must initiate, as soon as possible, the implementation of the project for making composite flours for human consumption.

2. The inclusion of vitamin and mineral enrichment of the composite flours with those vitamins and minerals which are deficient in the Bolivian diet.

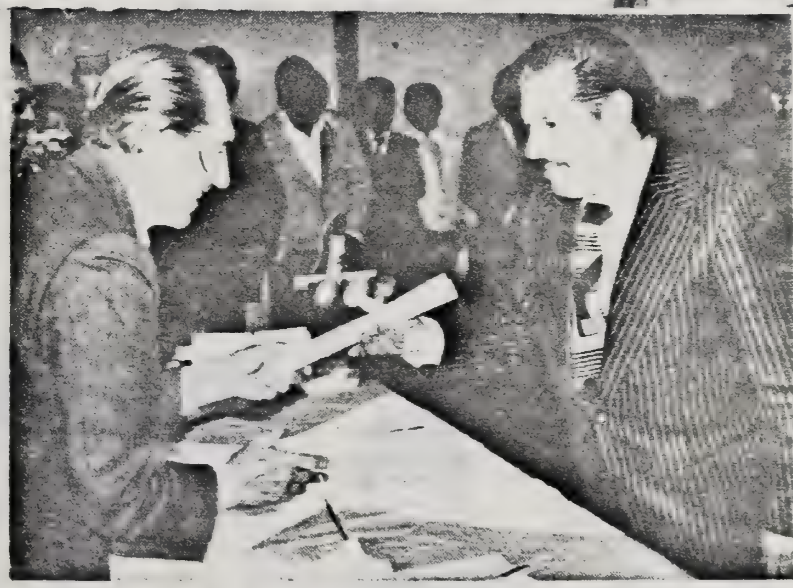
3. A gradual substitution of wheat imports with national crops, together with a total prohibition of wheat flour imports. This policy will help guaranty a positive and effective industrialization of national crops.

4. To support and stimulate the cultivation of national crops that can be substituted for wheat by national implementation of technical, economical, and financial assistance to farmers and millers.

5. The standardization of baking processes throughout the nation but taking into account the climatic, geographic and other necessary factors.

6. The immediate implementation of the Project "Improving the Nutritional Value of Wheat Foods" by including soy, the feasibility of which has been demonstrated, while such implementation must be gradual with the other cereals which are still in the stage of research (quinoa, rice and corn).

7. Provide greater logistical and financial support to the DGNT. Also, this institution must coordinate with all other national institutions any task inherent to the economic and industrial objectives of the project.



El ministro de Industria y Comercio, Tomás Guillermo Elío, clausuró el pasado viernes el curso que sobre mejoramiento nutricional de los alimentos lácteos , se realizó en el Instituto Superior de Administración Pública. El secretario de Estado conoció las conclusiones de ese seminario y procedió a la entrega de diplomas de asistencia a los alumnos que siguieron el curso. Las fotografías recogen dos aspectos del acto de clausura.

Concluyó seminario de mejoramiento nutricional de los alimentos lácteos

Con la firma del convenio de extensión del proyecto "Mejoramiento Nutricional de los Alimentos a base de Harina de Trigo", concluyó ayer en la tarde el seminario que sobre el tema se realizó a partir del lunes último con el coauspicio del ministerio de Industria y Comercio, la Western Regional Research Center de Estados Unidos y USAID/B/

En el acto de clausura el director general de normas y tecnología, Ing Gregorio Bernal, se refirió a la importación del evento y los resultados obtenidos que permitirán "incidir en el mejoramiento nutricional que se busca para la población de menores ingresos del país".

EL CONVENIO

El ministro Tomás Guillermo Elío asistió al acto de firma del Convenio de Extensión del Proyecto que debía concluir en abril del presente año y ahora está siendo ampliado hasta abril de 1980 con el apoyo del Departamento de Agricultura de Estados Unidos.

En esta forma se dijo "queda asegurada la valiosa cooperación técnica" de la Western Regional Research Center, y los trabajos que impulsa tanto la Direccion General de Normas y Tecnología del ministerio de Industria y Comercio, como el Instituto Nacional de Alimentación y Nutrición.

A nombre de los numerosos participantes, agradeció por la "valiosa experiencia adquirida en el seminario" el Ing. Julio Grájeda.

Finalmente, se hizo entrega de diplomas y certificados a los disertantes y participantes, sirviéndose un cóctel en su honor.

MAURA BEAN | TONI BETSCHART | BOB ENOCHIAN | FRED BARRETT | DAVID BUSTOS

Minster CABERELLA Agric. | Director General G. BERNAL DGNT, MICT | DAVID FELLERS | G. ARABE USAID | MAURA BEAN | CARLOS CACERES Sub Secretary Commerce | EDGAR MIRANDA

Appendix B-13

CONTRACT PROPOSAL

Title: Consumer Acceptance of Bread Made with Composite Flours in Bolivia

Objectives: To determine the comparative acceptance by consumers of breads made entirely from wheat flour, with breads made from the following composite flours: (1) 95% wheat and 5% soy throughout Bolivia; (2) 90% wheat, 5% soy, and 5% quinoa in the Altiplano; (3) 90% wheat, 5% soy, and 5% corn in the Valles and Yungas; and (4) 90% wheat, 5% soy, and 5% rice in the Lowlands. All of the composite flours will contain a small quantity of bromate as a dough conditioner.

Selection of Respondents: Respondents will be people in shopping centers or markets in representative rural and urban areas in the 3 major geographical areas. The sample of respondents shall be approximately proportional to the population in each geographic area. In the urban areas, an attempt will be made to obtain representation in high, medium and low income areas. Thus, the number of respondents and number of locations shall be distributed approximately as follows:

	Urban Areas		Rural Areas		Total	
	Respondents No.	Locations No.	Respondents No.	Locations No.	Respondents No.	Locations No.
Altiplano	360	6*	720	12	1080	18
Valles & Yungas	240	3**	720	12	960	15
Lowlands	180	3**	180	3	360	6
TOTAL	780	12	1620	27	2400	39

* 2 low, 2 medium, and 2 high income locations in La Paz; ** 1 each of low, medium and high income locations in Cochabamba and Santa Cruz.

To obtain equal representation from morning and afternoon shoppers, approximately one-half of the respondents at each location shall be selected in the morning (about 1000 to 1200 hours), and the other half in the afternoon (about 1600 to 1800 hours). Insofar as possible selection of respondents shall be random; however, interviewers will attempt to obtain responses from approximately equal numbers of male and female respondents representing all age groups. To accomplish this, as the number of respondents for morning and afternoon sessions approaches the desired count, volunteers not meeting the sex and age qualification will be offered a sample of bread without being asked to complete a test form.

Procedure: At the test locations, each respondent will be presented with 3 samples individually and in random order of the type of bread product that is most common for that location. The three samples will be made from the flour blends selected for that location, as described under the objectives. Respondents will then observe, taste, and rate each sample independently. They will then compare the samples, indicating which they prefer and will respond to certain other questions (see attached Test Form). Neither respondents nor interviewers shall know the composition of the bread samples until the entire test has been completed. They will simply be told that bakers in Bolivia are attempting to improve bread products through the use of new methods and would like to get people's opinions about breads made with these methods.

Individual responses will be tabulated and averaged by the various demographic criteria used for classification of the respondents, statistical tests of significant differences will be made, and a report of the results will be prepared in both Spanish and English.

Responsibilities: The test will require the participation of a market research firm, the DGNT, WRRC, and bakers. Once the market research firm has been selected--cooperatively by DGNT and WRRC--the test locations will be designated by the firm, with approval by DGNT and WRRC. This will be done by use of maps, knowledge of the locations, and, if necessary, by site visits.

When the locations have been selected, the day or days that the test will be conducted at each location will be mutually agreed upon by the market research firm, the DGNT and WRRC. The market research firm will then acquire the necessary approvals for utilizing specific shopping center or market areas for the test, will provide signs for publicizing the test at the test locations, will arrange for providing tables and chairs at the test sites, paper plates on which to place the bread samples, a place to store the bread samples, a supply of pencils, a supply of test forms, and a supply of bags in which the respondent can carry away that part of the sample not eaten. The market research firm will also be responsible for hiring and training the interviewers who will present bread samples and test forms to the respondents and will see that the test forms are properly executed.

The DGNT, in cooperation with WRRC, will be responsible for making arrangements with and paying bakers to produce an adequate supply of the appropriate type of bread samples for each location on the day of the test. Insofar as possible, bakers who normally produce bread for the test locations will be selected and will be instructed on how to make the bread samples with the composite flours. The DGNT will acquire or produce adequate quantities of the nonwheat flours and supply these to the cooperating bakers at each location to blend with their regular supply of wheat flour

To obtain equal representation from morning and afternoon shoppers, approximately one-half of the respondents at each location shall be selected in the morning (about 1000 to 1200 hours), and the other half in the afternoon (about 1600 to 1800 hours). Insofar as possible selection of respondents shall be random; however, interviewers will attempt to obtain responses from approximately equal numbers of male and female respondents representing all age groups. To accomplish this, as the number of respondents for morning and afternoon sessions approaches the desired count, volunteers not meeting the sex and age qualification will be offered a sample of bread without being asked to complete a test form.

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Individual responses will be tabulated and averaged by the various demographic criteria used for classification of the respondents, statistical tests of significant differences will be made, and a report of the results will be prepared in both Spanish and English.

Disbursements: The following disbursements to the market research firm are proposed providing the above schedule is adhered to:

Initial - 25%

End of Week 7 - 25%

End of Week 10 - 25%

Final report - 25%

Test Form

After you have tasted the sample of bread you have been given, please rate it by checking one of the boxes for that sample before asking for the next sample.

	Sample A	Sample B	Sample C
1. Like extremely	[ ]	[ ]	[ ]
2. Like very much	[ ]	[ ]	[ ]
3. Like moderately	[ ]	[ ]	[ ]
4. Like slightly	[ ]	[ ]	[ ]
5. Neither like nor dislike	[ ]	[ ]	[ ]
6. Dislike slightly	[ ]	[ ]	[ ]
7. Dislike moderately	[ ]	[ ]	[ ]
8. Dislike very much	[ ]	[ ]	[ ]
9. Dislike extremely	[ ]	[ ]	[ ]

After you have tasted all 3 samples, please indicate which sample you prefer? ____ Why do you prefer this sample? ________________________________

____

Please complete the following: Sex _____ Age: under 16 _____; 16 to 20 ____ 21 to 30 _____; 31 to 40 _____; 41 to 50 _____; over 50 _____.

For office use only

Location ________________________ Code __________________

Urban __________ Rural __________

Income Level ____________________

Date _____________ Time __________ Interviewer ________________________

Appendix B-14

PRODUCTS MADE WITH A BASE OF COMPOSITE FLOURS

STUDY OF ACCEPTABILITY

AGENCY OF STANDARDS AND TECHNOLOGY
MINISTRY OF INDUSTRY, COMMERCE AND TOURISM
(DGNT, MICT)

MAY 1980

CBPI-
Center of Bolivian Industrial Productivity
Contractor

1. Background and Objective of the Study

1.1 Background

The DGNT, MICT is in charge of the project, "The Nutritional Improvement of Foods Based on Wheat Flours. In this work, the Ministry counts on technical assistance from WRRC, USDA. Among the activities developed during the project were technical tests to establish the levels of substitution of wheat flour with other flours such as soy, corn or quinoa, principally in the area of bread making.

The products made with these flours, designated composite flours, required consumer acceptability studies, especially "pan de batalla" (battle bread). CBPI was contracted to conduct the investigation and analysis.

1.2 Objective and Methodology

The objective of the study is to establish indices that demonstrate the degree of acceptability of products, especially pan de batalla, based on composite flours. For this purpose, it was agreed to run a national opinion survey embracing both urban and rural areas. The methodology involved planning, execution, interpretation, inferences, conclusions and recommendations about the degree of acceptance. The level of substitutions in the composite flours were determined by the DGNT.

For a more effective study, it was divided into three phases:
Phase I. Plan and Organization of the Investigation. In this phase, an indepth study was done of the population characteristics such as size and composition according to socio-economic stratification, sex, and age range. The sample for testing was identified as to size, stratification, geographic area and urban or rural area. Questionaires were prepared, personnel needs agreed upon and the selection and training of the selected staff was carried out. A pilot test was run (see Appendix 1).
Phase II. Execution of the Investigation. The execution corresponds to conducting the investigation according to the plan and organization outlined in Phase I (see Appendix 2).
Phase III. Analysis of Data and Evaluation of Results. In this phase, the processing of the information and the interpretation of the results were done in order to determine the indices of acceptability (see Chapter 2 of the present report).

2. Analysis of Data and Evaluation of Results.

The results and analysis are presented in Point 2.1. The procedures that were employed to determine the results are presented in Points 2.2 and 2.3

2.1 Interpretation of Results.

2.1.1 General Investigation.

2.1.1.1 Acceptability of pan de batalla. The principal question of the investigation was based on the following scale of references:

1) I like it a lot
2) I like it
3) I like it a little
4) I am indifferent
5) I dislike it a little
6) I dislike it
7) I dislike it alot

When the questionaires were completed, only the consultants knew the make-up of the composite flour breads.

The samples tested were:
National Level:
Sample "A". Bread prepared from 100% wheat flour
Sample "C". Bread prepared from 95% wheat flour and 5% defatted soy flour
These samples were maintained constant for La Paz, Cochabamba and Santa Cruz.
Regional Level:
La Paz: Sample "B1". Bread prepared from 90% wheat flour, 5% quinoa flour, and 5% defatted soy flour
Cochabamba: Sample "B2". Bread prepared from 90% wheat flour, 5% quinoa flour, and 5% defatted soy flour
Santa Cruz: Sample "B3". Bread prepared from 90% wheat flour, 5% corn flour, and 5% defatted soy flour

The results obtained indicate that all samples had a preference in the area of level 3 acceptability (like a little). That is to say, the median of preference is found in the range from 3 (It pleases me a little) to **1** (It pleases me a lot). These results are summarized in TABLE 1. The computations and tabulations are found in 25 tables and the graphs of distribution frequency and the statistical indices such as the means, standard diviation, variance and others. It was affirmed for all types of breads and for all regions, strata, age groups and sex that the breads were acceptable.

In this respect it is necessary to reiterate the considerations established in order to determine the sample size.
National Level: Relative error 5%
Proportion of appreciation 12.5%-10%
Regional Levels: Relative error 10%
Proportion of apprreciation from 7.5% and 2.5% to 10%

In TABLES 2-6 are shown the parameters of comparison for an analysis of significant difference, processed as explained in Point 2.2 and 2.3.

Table 2 - Comparisons of 100% wheat flour bread with composite breads at the national and regional levels. At the national level, the results for sample "A" (100% wheat flour) and Sample "C" (5% defatted soy flour) show a significant difference, that is to say, although both products have acceptability ($A = 2.16$, $C = 2.70$), sample "A" has greater acceptability. For significance at the 0.05 level, the estimator t must be 1.96 (if a probability of 97.5% is considered to be within reason to the symmetry of the student's curve, which is the case, for being $n > 120$, holds to the adoption to the normal curve). For significance at the 0.02 level the estimator t must be 2.32.

As has already been indicated, the only comparison that can be made at the national level is the 100% wheat flour bread with the 5% defatted soy flour bread. The "B" samples were different in La Paz, Cochabamba, and Santa Cruz.

The results at the regional level for La Paz likewise showed significant differences between "A" 100% wheat flour bread and "B1" the 90/5/5 wheat/quinoa/soy bread. Between "C" the 5% soy bread and "B1" the 90/5/5 wheat/quinoa/soy bread, there was no significant difference.

In Cochabamba, the difference for "A" and "B2" bread (90/5/5 wheat/quinoa/soy) is significant. But in the case of "A" versus "C" there is no significance. In the case of "C" versus "B2", the difference is significant.

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CUADRO 1

MEDIAS DE ACEPTABILIDAD - ENCUESTA GENERAL

	A		B		C	
	$\bar{x}$	s^2	$\bar{x}$	s^2	$\bar{x}$	s^2
La Paz	2,19	1,75	2,65	1,80	2,72	2,05
Cochabamba	2,51	2,07	2,20	1,38	2,59	2,07
Santa Cruz	1,77	1,25	2,36	1,24	2,76	1,53
Total	2,16	1,80			2,70	1,91
LA PAZ						
Rural	2,34	2,10	2,7	1,77	2,84	2,14
Alto	1,96	1,43	2,99	1,93	2,28	1,73
Medio	2,17	1,45	2,6	1,75	2,80	2,1
Bajo	1,96	1,40	2,2	1,70	2,68	1,69
COCHABAMBA						
Rural	2,41	1,95	1,94	0,77	2,39	1,7
Alto	2,73	2,11	2,55	1,82	2,60	2,47
Medio	2,62	2,35	2,59	1,97	2,57	2,10
Bajo	2,37	1,99	1,97	1,20	2,93	2,27
SANTA CRUZ						
Rural	1,72	1,07	2,05	0,96	2,56	1,45
Alto	1,62	1,05	2,32	1,01	2,69	1,64
Medio	1,56	0,85	2,49	1,17	2,82	1,20
Bajo	2,24	1,86	2,9	1,59	3,17	1,62

$\bar{X}$ Media
s2 Varianza

CUADRO N°2

PARAMETROS DE COMPARACION PARA EL ANALISIS DE DIFERENCIAS SIGNIFICATIVAS

NIVEL: Nacional Total

MUESTRA	TABLA	MEDIA	n	VARIANZA	ESTIMADOR	DIFERENCIA
A	24	2,16	2,889	1,80	15,10	Significat.
C	24	2,70	2,889	1,91		

NIVEL: Regional - La Paz Total

MUESTRA	TABLA	MEDIA	n	VARIANZA	ESTIMADOR	DIFERENCIA
A	6	2,19	1,389	1,75	9,13	Significat.
B_1	6	2,65	1,389	1,80		
A	6	2,19	1,389	1,75	10,16	Significat.
C	6	2,72	1,389	2,05		
C	6	2,72	1,389	2,05	1,33	Insignific.
B_1	6	2,65	1,389	1,80		

NIVEL: Regional - Cochabamba - Total

MUESTRA	TABLA	MEDIA	n	VARIANZA	ESTIMADOR	DIFERENCIA
A	12	2,51	750	2,07	4,57	Significat.
B_2	12	2,20	750	1,33		
A	12	2,51	750	2,07	1,08	Insignific.
C	12	2,59	750	2,07		
C	12	2,59	750	2,07	5,75	Significat.
B_2	12	2,20	750	1,38		

NIVEL: Regional - Santa Cruz - Total

MUESTRA	TABLA	MEDIA	n	VARIANZA	ESTIMADOR	DIFERENCIA
A	18	1,77	750	1,25	10,26	Significat.
B_3	18	2,36	750	1,24		
C	18	2,76	750	1,53	6,59	Significat.
B_3	18	2,36	750	1,24		
A	18	1,77	750	1,25	16,28	Significat.
C	18	2,76	750	1,53		

Comparing the results of both regions, it can be inferred that all the samples have acceptability though the differences do not correspond in their magnitude. This demonstrates that acceptabilities are different in each region.

According to the responses to Question No. 2 (If you have a preference for one sample, indicate that and if possible the reason for your selection?), contained in Appendix 3, different reasons of general preference exist that correspond to physical aspects of the samples since the samples for La Paz and Cochabamba were the same composition . Perhaps the manufacture of the bread accounts for the differences.

One comparison would be:

Sample	Department	Mean	Variance	n
"A"	La Paz	2.19	1.75	1,389
"A"	Cochabamba	2.51	2.07	750

The t value of 5.05 indicates the difference is significant.

"B1"	La Paz	2.60	1.80	1,389
"B2"	Cochabamba	2.20	1.38	750

The t value of 6.03 indicates the difference is significant.

"C"	La Paz	2.72	2.05	1,389
"C"	Cochabamba	2.59	2.07	750

The t value of 1.99 indicates the difference is barely significant.

With the result from Santa Cruz, one can only compare samples "A" and "C".

"A"	La Paz	2.19	1.75	1,389	t = 7.76
"A"	Santa Cruz	1.77	1.25	750	
"C"	La Paz	2.72	2.05	1,389	t = 0.67
"C"	Cochabamba	2.76	1.53	750	

In conclusion, it can be affirmed that the wheat flour bread (sample "A") is liked better in Santa Cruz and La Paz compared to Cochabamba. The soy bread (sample "C") is liked better in Cochabamba and La Paz compared to Santa Cruz.

TABLE 3 - Age Ranges. The difference in preference, in general, are insignificant. (There are two cases where differences are significant but at t values very close to 1.96 --- the needed value for significance.)

TABLE 4 - Rural and Urban Areas. At the national level, differences are insignificant for samples "A" and "C" (100% wheat and 95/5 wheat/soy). At the regional level, sample "A" is not influenced by either rural or urban area. That is to say, the differences are insignificant for Cochabamba and Santa Cruz where the bread was prepared in the cities for the corresponding urban and rural areas. In La Paz, the difference is significant with the greatest preference in the urban area (but 25% of the breads were prepared in the rural area and may not have been as good as those produced in La Paz city).

There were some significant differences with samples "B1", "B2" and "C" between urban and rural but no general preferences could be discerned.

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CUADRO N° 3

PARAMETROS DE COMPARACION PARA EL ANALISIS DE DIFEREN CIAS SIGNIFICATIVAS

NIVEL: NACIONAL ;'REGIONAL
PARAMETRO: RANGOS DE EDAD

STRA	RANGO DE EDAD AÑOS	TABLA Nº	MEDIA	n	VARIANZA	ESTIMADOR	DIFERENCIA
"A"	15-34	24	2,19	1.746	1.81	0.17	Insignific.
	35-54	24	2,18	829	1.89		
"B_1"	15-34	24	2.75	817	1.91	2.40	Significat.
	35-54	24	2,56	414	1.63		
"B_2"	15-34	24	2,27	435	1.52	1.28	Insignific.
	35-54	24	2,15	220	1.17		
"B_3"	15-34	24	2,41	494	1.25	2.59	Significat.
	35-54	24	2,18	195	1.05		
"C"	15-34	24	2,71	1.746	1.95	0.17	Insignific.
	35-54	24	2,70	829	1.94		

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CUADRO 4

PARAMETROS DE COMPARACION PARA EL ANALISIS DE DIFERENCIAS SIGNIFICATIVAS

NIVEL: NACIONAL; REGIONAL

PARAMETRO: Area Urbana y Rural

MUESTRA	AREA	TABLA	MEDIA	VARIANZA	ESTIMADOR	DIFERENCIA
"A"	Rural	19	2,21	1.91	1.60	Insignific.
	Urbana	23	2,13	1.65		
"B_1"	Rural	19	2,72	1.78	1.96	Insignific.
	Urbana	23	2,58	1.78		
"B_2"	Rural	19	1 94	0.78	5.37	Significat.
	Urbana	23	2,37	1.72		
"B_3"	Rural	19	2,05	0.95	6.69	Significat.
	Urbana	23	2,57	1.30		
"C"	Rural	19	2,67	1.94	0.97	Insignific.
	Urbana	23	2,72	1.90		

TABLE 5 - Socio-Economic Stratification. Sample "A" has no significant difference in preference as a function of socio-economic stratification. The samples of composite flour breads "B1", "B2" and "C" do have significant differences in 10 out of 12 situations, that is to say (the number of) dislikes determine variations in preference. It is affirmed that sample "B1" and "B2" have greater prefernce in the middle and lower stratification and that "B3" and "C" have greater preference in the middle and high stratifications.

TABLE 6 - Sex. The differences are insignificant. It is determined, therefore that sex has no influence on preference

2.1.1.2 Additional Questions.

In accordance with the structure of the general questionaire, a second question of indicative character was presented, the answers to which are not subject to tabulation. In a general way, it can be appreciated that the answers are obvious, that is to say, they offer substantiation of the levels of like or dislike as the case may be. The coefficents of response indicate that the greatest indices are in the high stratifications with 50% as the average for all. At the regional level, la Paz indicates 61%, Cochabamba 57% and Santa Cruz 53%. The middle stratifications indicate a general average of 35% and the lower stratifications, 12%. With regard to the rural area, the responses obtained, although they have an indices of reponse of 45% for the question to be answered in direct form, do not have, for the interviewer, the same qualitative value that the indices previously mentioned had in the urban area.

Given the diversity of opinions, that in some cases may represent some aspect of a technological kind, or in the make-up of the samples, or in their presentation, or in some other aspects that seems to elude the objectives of the study, a complete list of all the responses obtained is given so that the DGNT can analyze and take note of those that it considers of the greatest relevancy for the purposes of the project in global form. The complete list mentioned is given in Appendix 3.

2.1.2 Home Interviews (Bread and Pastas)

The fundamental objective of the DGNT was oriented to the acceptability of breads but also to make a preliminary sounding about the acceptability of pastas which was accomplished through the use of home interview in each of the urban areas, La Paz, Cochabamba and Santa Cruz.

The number of interviews was taken as a percentage relationship of the number of questionaires of the high and middle stratification (socio-economic) that tested the breads. In consequence, the size is not bound to any statistical analysis and the results should be considered as points not susceptible to statistical inference. In order to have a comprehensive reflection, 175 family interviews were analyzed, 87 from La Paz, 45 from Cochabamba, and 43 from Santa Cruz.

TABLE 7 gives the relation of the frequency of the number of the members per family and their percentage distribution in relation to the total number of questionaires done. Likewise, the means were determined that give an indication of the average of members per family. The highest incidence corresponds to Santa Cruz, with a mean of 5.93 members per family, the next was Cochabamba with 5.56 members per family and then La Paz with 4.77 members per family. The overall mean is 5.25 members per family. The indices are in accordance with the national indicators based on the 1976 census which gave an average 5 members per family.

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CUADRO 5

PARAMETROS DE COMPARACION PARA EL ANALISIS DE DIFERENCIAS SIGNIFICATIVAS

NIVEL: NACIONAL ; REGIONAL

PARAMETRO: Estratos socio-económicos

MUESTRA	ESTRATO	TABLA	MEDIA	n	VARIANZA	ESTIMADOR	DIFERENCIA
"A"	Alto	20	2.09	509	1.71	0.50	Insignific.
	Medio	21	2.13	540	1.68		
	Alto	20	2.09	509	1.71	0.75	Insignific.
	Bajo	22	2.15	540	1.63		
	Medio	21	2,13	540	1,68	0,26	Insignific.
	Bajo	22	21,5	540	1,63		
"B_1"	Alto	20	3.00	219	1.85	3.15	Significat.
	Media	21	2.60	240	1.74		
	Alto	20	3.00	219	1.85	6.63	Significat.
	Bajo	22	2.20	240	1.37		
	Medio	21	2.60	240	1.74	3.52	Significat.
	Bajo	22	2.20	240	1.37		
"B_2"	Alto	20	2.55	150	1.75	0.26	Insignific.
	Media	21	2.59	150	1.90		
	Alto	20	2.55	150	1.75	4.14	Significat.
	Bajo	22	1.97	150	1.19		
	Medio	21	2.59	150	1.90	4.32	Significat.
	Bajo	22	1.97	150	1.19		
"B_3"	Alto	20	2,32	150	0.97	1.44	Insignific.
	Medio	21	2.49	150	1.12		
	Alto	20	2.32	150	0.97	4.59	Significat.
	Bajo	22	2.91	150	1.51		
	Medio	21	2.49	150	1.12	3,17	Significat.
	Bajo	22	2.91	150	1.51		
	Alto	20	2.51	509	1.94	2.70	Significat.
	Medio	21	2.74	540	1.87		
	Alto	20	2.51	509	1.94	4.48	Significat.
	Bajo	22	2.89	540	1.84		
	Medio	21	2.74	540	1.87	1.81	Insignific.
	Bajo	22	2.89	540	1.84		

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CUADRO 6

PARAMETROS DE COMPARACION PARA EL ANALISIS DE DIFERENCIAS SIGNIFICATIVAS

NIVEL: NACIONAL ; REGIONAL
PARAMETRO: Sexo

ESTRA	SEXO	TABLA	MEDIA	n	VARIANZA	ESTIMADOR	DIFERENCIA
"A"	Masculino	24	2.20	1.436	1.80	1.42	Insignific.
	Femenino	24	2.13	1.453	1.74		
"B_1"	Masculino	24	2.61	690	1.67	1.27	Insignific.
	Femenino	24	2.70	699	1.85		
"B_2"	Masculino	24	2.24	375	1.50	1.04	Insignific.
	Femenino	24	2.15	375	1.30		
"B_3"	Masculino	24	2.38	371	1.22	0.37	Insignific.
	Femenino	24	2.35	379	1.21		
"C"	Masculino	24	2.77	1.436	2.04	2.72	Significat.
	Femenino	24	2.63	1.453	1.78		

CUADRO 7

MIEMBROS POR FAMILIA

Nºmiembros por familia	LA PAZ *Nº	LA PAZ %	COCHABAMBA *Nº	COCHABAMBA %	SANTA CRUZ *Nº	SANTA CRUZ %	TOTAL *Nº	TOTAL %
2	3	3	-	0	2	5	5	2
3	12	14	5	10	5	11	22	13
4	21	24	9	20	8	19	38	22
5	31	36	9	20	2	4	42	24
6	12	14	12	27	11	26	35	20
7	3	3	4	9	5	12	12	7
8	4	5	3	7	4	9	11	6
9	1	1	-	0	2	5	3	2
10	-	0	3	7	2	5	5	2
11	-	0	-	0	1	2	1	1
12	-	0	-	0	1	2	1	1
TOTAL	87	100	45	100	43	100	175	100
MEDIA	4,77		5,56		5,93		5,25	

(*) Número de familias encuestadas.

Therefore, the results that are given below make an extension for the number of family members and use the family unit as a whole.

2.1.2.1 Acceptability of Bread

Although the size of the investigation has not been determined statistically, TABLE 8 demonstrates the results on acceptability of all the products by its mean of preference. Sample "A" in La Paz and Santa Cruz has the greatest preference for bread. Sample B enjoys greater acceptance in Cochabamba. In the three cities, Sample "C" demonstrates the least preference.

2.1.2.2 Additional Questions

The home interview includes in its structure additional questions that have reference to aspects colateral to but the same as the objectives of this study which are of interest to MICT. The questions are of two types: tabulatable and open-ended. The first represents only indices indicating that the home interview is not subject to statistical analysis of the whole population but that they can be considered as exact results. Based on the indicators in the family questionaire, The MICT will be able later to approach surveys of opinion of greater breadth of similar types that may be seen as useful. Below are given the results obtained following the sequence found in the family questionaire.

Question II. If you have a preference for one of the samples, indicate which and if possible specify the reasons for your choice.

This question, whichis the same as that contained in the general test, improved the coefficients of response at 62% (see TABLE 9), the department of La Paz being the most significant with 72%, then Cochabamba with 56% and Santa Cruz with 44%. For the reason noted in previous paragraphs, a list of responses obtained are given in Appendix 4, but without great commentary.

Question III. Atwhat times is bread generally bought for daily consumption in your home?

This question for its simplicity was answered in 100% of the cases giving as a result the following times: Morning 7:00-8:00 am; afternoon 3:30-5:00 pm. These intervals are the same for all regions inspite of different habits and customs.

Question IV. Are you in agreement with the actual system of marketing bread? or would you prefer to buy bread by weight?

This question had a high coefficient of response of 98% (TABLE 10). In La Paz, 72% were inclined toward the weight option, in Cochabamba 60 %, and in Santa Cruz 60%. The overall average was 66%. Some 24% voted for the present system in La Paz, 40% in Cochabamba, and 37% in Santa Cruz. The overall average for this option was 31%.

It is important to mention that the inclination toward the selling of bread by weight has its origin in the present day system which is extremely deficient in control of weight of the pieces and its relation to price.

Question V. What suggestions can you give for improving the present way bread is marketed?

This question turned out, in its results, to be complimentary to the previous one obtaining coefficient of response of 79% in La Paz, 62% in Cochabamba and

CUADRO 8

ENCUESTA DOMICILIARIA - MEDIAS DE ACEPTACION - PAN DE BATALLA

	A		B		C	
	$\bar{x}$	s^2	$\bar{x}$	s^2	$\bar{x}$	s^2
La Paz	2.16	1.52	2.55	1.26	3.02	1.96
Cochabamba	2.88	2.24	2.48	2.16	3.04	1.88
Santa Cruz	1,81	1,26	2.37	1.34	2.95	1.39
TOTAL	2.26	1.75			3.01	1.93

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CUADRO 9

COEFICIENTES DE RESPUESTA

(panes)

	II		V		VI	
	N°	%	N°	%	N°	%
La Paz	64	74	69	79	73	84
Cochabamba	25	56	28	62	38	84
Santa Cruz	19	44	22	51	22	51
TOTAL	108	62	119	68	133	76

CUADRO 10

	ACTUAL		POR PESO		NO OPINAN		N° ENCUESTAS	
	N°	%	N°	%	N°	%	N°	%
La Paz	21	24	63	72	3	3	87	100
Cochabamba	18	40	27	60			45	100
Santa Cruz	16	37	26	60	1	3	43	100
TOTAL	55	31	116	66	4	2	175	100

51% in Santa Cruz. Overall the level was 68%. In a general way, the answer tended toward more hygiene control during production, toward control of weight in relation to the price and toward the creation of sites for special sales. Distribution to the home was mentioned repeatedly as was the sale with wrapping. In Appendix 5, the complete list of answers obtained are given.

Question VI. Would you be able to indicate which characteristics are those you look for in buying the bread of your preference?

This question is the one which presented the greatest coefficient of response; 84% in La Paz, 84% in Cochabamba and 51% in Santa Cruz. The overall response was 76% (TABLE 9).Not withstanding the high coefficient of response, the answers are not clearly defined which lead to the conclusion that given the circumstances in which the product is made and sold, there is little option or choice for the public consumer. The responses, in various cases, indicate that once again the aspects of hygiene are those of greatest concern. In appendix 6, are given the responses obtained.

2.1.2.3 Acceptability of Pastas

TABLE 11 gives the results obtained with pasta made with 70/25/5 wheat/corn/soy, and in accordance with the means, it can be shown that it is acceptable in all regions. Never-the-less, this good acceptability is conditioned to that which is observed in 2.1.2.4. that is to say, the greatest number of those interviewed, made reference to the long preparation time and the fragility of the noodles once they had been prepared.

2.1.2.4 Additional Questions

As was true for the acceptability of bread tests, the acceptability of noodles included additional questions that permit the visualization of some other characteristics of interest for the MICT.

Question VII. Briefly describe the usual method by which you prepare noodles at home?

This question tries to establish a relation with the test of acceptability in order to facilitate an analysis of its utilization versus acceptance. Never-the-less, given the circumstances of offering a sample of only one type of noodles, the test is limited only to utilization of this type noodle.

For greater clarity, it can be indicated that various homes surveyed established that they habitually consume noodles, nevertheless a test has not been effected under this modality of consumption, because the type of noodles used did not adapt itself to this utilization. For the noodle sample mentioned, it can be established that a test of acceptability was done using the noodles in soup, chile sauce, and caseroles. It was made difficult to effect an analysis of the frequency of the preparation of the noodles in the form mentioned, so certainly this aspect is highly circumstancial.

Question IX. In general, how do family members compare these noodles with the noodles they usually eat? The question presented three alternatives: better, the same, worse.

TABLE 12 gives the results from which it can be inferred that it has a high coefficient of response of 97%. Overall, 47% voted for the option the SAME, 35% for the option BETTER, and 14% for the option WORSE. From the previous question, it can be shown that 82% of those interviewed accepted the product. With regard to the regional relation, 49% voted for the option BETTER in Santa Cruz, 33% in La Paz, and 24% in Cochabamba. For the option SAME, the results were

CUADRO 11

ENCUESTA DOMICILIARIA
MEDIAS DE ACEPTACION
PASTA DE FIDEOS

La Paz	2.33
Cochabamba	2.02
Santa Cruz	1.65
TOTAL	2.08

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CUADRO 12

	MEJOR		IGUAL		PEOR		NO OPINAN		N°ENCUEST.	
	N°	%	N°	%	N°	%	N°	%	N°	%
La Paz	29	33	34	39	20	23	4	5	87	100
Cochabamba	11	24	30	67	4	9			45	100
Santa Cruz	21	49	19	44	1	2	2	5	43	100
TOTAL	61	35	83	47	25	14	6	3	175	100

67% in Cochabamba, 44% in Santa Cruz, and 39% in La Paz. Finally, for the option WORSE, the percentages were 23% in La Paz, 9% in Cochabamba and 2% in Santa Cruz.

Once again, it is appropriate to emphasize that the previous results cannot be generalized to the types or forms of noodles that exist in the market but only to the type of noodle similar to that supplied for this investigation.

Question X. If it is possible, would you be able to indicate some of the reasons for your choice?

The coefficient of response to the question was low at 47% overall (TABLE 13) which can be considered low since it does not correspond with question IX, though being complementary to it. The responsesobtained are obvious, according to the tester. Given the great breadth of answers in this respect, the answers are listed in Appendix 7.

Question XI. Can you indicate with what frequency noodles are eaten in your home?

The coefficient of response was 94%. TABLE 14 gives the frequency of consumption by regions (La Paz, Cochabamba and Santa Cruz) and the overall frequency in times consumed per week. At the national level, the mean is 2.43 times per week. La Paz recorded at mean of 2.16, Cochabamba 3.05 and Santa Cruz 2.46 times per week. An analysis of the means permits the establishment of a minimum variation between the regions considered.

Question XII. Would you like to make some additional comments?

The question was oriented toward giving families interviewed the opportunity to give additional criteria or an amplification to the specific questions in the questionaire. A coefficient of response of 45% was obtained at the overall level, which indicated that less than half utilized this opportunity. The greatest part of the responses referred to two important aspects which are: the greater time of preparation for the noodles and their fragility once prepared, that is to say, the loss of their shape or their melting away.

There are also answers about different topics whose results are complex to condense, therefore, a complete list of the reponses obtained is given in Appendix 8.

2.2 etc., etc., etc.

Appendix B-14

CUADRO 13

COEFICIENTES DE RESPUESTAS

(pastas)

	X		XII	
	N°	%	N°	%
La Paz	43	49	48	55
Cochabamba	20	44	18	40
Santa Cruz	20	46	13	30
TOTAL	83	47	79	45

CUADRO 14

FRECUENCIA DE CONSUMO DE FIDEOS

Veces por semana	LA PAZ		COCHABAMBA		SANTA CRUZ		TOTAL	
	N°	%	N°	%	N°	%	N°	%
-1	8	9	1	2	3	7	12	7
1	11	13	1	2	6	14	18	10
2	32	37	12	28	12	28	56	32
3	23	26	14	31	8	19	45	26
4	5	6	14	31	5	12	24	14
5	-	0	1	2	1	2	[illegible]	1
6	-	0	1	2	2	4	3	2
+ 7	3	3	0	-	0	0	3	2
No opinan	5	6	1	2	6	14	11	6
Total	87	100	45	100	43	100	175	100
Media	2,16		3,05		2,46		2,43	

Appendix B-15

Letter of Agreement

Parties to the Agreement:

This Letter of Agreement is entered into by La Inglesa Flour Mill SA, represented by its Manager and the Direccion General de Normas y Tecnologia (DGNT), represented by its Director.

Purpose of Agreement:

It is the purpose of this Agreement to:

1. Establish a commercial capability in Bolivia to produce composite flours by admixing flour of wheat with flours of soy and rice or corn or quinoa at a wheat flour mill.

2. Demonstrate the feasibility of producing composite flours at a wheat flour mill in Bolivia.

3. Produce a supply of appropriate composite flours for use in the Project, "Improving the Nutritional Quality of Wheat Foods in Bolivia." The DGNT is the executor of this project and the Western Regional Research Center (WRRC), USA, participates by providing technical and financial assistance.

La Inglesa Flour Mill SA, located in La Paz, is the commercial wheat flour mill to be refitted to provide the commercial capability to produce composite flours.

Agreement:

It is agreed between the parties designated above that the La Inglesa Flour Mill in La Paz shall be modified to provide a capability to produce composite flour at a rate of 12 metric tons per 24 hours. The detailed commitments below describe the division of tasks and costs to be borne by each party in order to achieve the modifications of the mill, demonstration of its operation, and the production of a supply of composite flours.

DGNT agrees to:

1. Arrange for delivery to La Inglesa, at no cost to La Inglesa, the following equipment:

    a. A self-powered gravimetric feeder, 50 pounds (23 kg) per minute maximum capacity, complete with shut-off gate. This unit is to be used to set the rate at which wheat is fed to the first break roll.

b. A screw-type volumetric feeder with integral hopper and with electric variable speed control, operating on 110-115 volt, 50 cycle, single phase current, and an adjustable capacity appropriate to meter into the flour stream a 5 or 10% addition (based on composite flour) of ingredients, that is, defatted soy flour or defatted soy flour in combination with rice flour or corn flour or quinoa flour. This feeder will also be provided with: (i) a feed hopper extension; (ii) hopper agitator; (iii) stainless steel and vinyl nitrile liner (food grade); and (iv) safety features for hazardous location.

c. A roll-type volumetric feeder with integral hopper, operating on 110-115 volt, 50 cycle, single phase current and of appropriate adjustable capacity to meter potassium bromate (diluted with inert ingredients) at rates that will provide 10 to 75 parts per million potassium bromate in the final composite flour. This unit will also be safe to operate in a hazardous location.

2. Reimburse La Inglesa up to US $600 for materials and costs for alteration of the mill to produce composite flours. Reimbursement is invoked when La Inglesa has expended US $1,000 of its own capital for refitting the mill and on presentation of appropriate receipts to DGNT.

3. Provide all ingredients, except wheat, for the production of composite flours during the demonstration and production of a supply of composite flour for the Project, "Improving the Nutritional Quality of Wheat Foods." The composite flour products shall not be sold by La Inglesa, and DGNT shall determine the utilization or disposal of the composite flours.

4. Following the demonstration and production of a supply of composite flours, ownership of DGNT supplied equipment shall pass to La Inglesa, but not later than the end of the Project, "Improving the Nutritional Quality of Wheat Foods."

<u>La Inglesa Flour Mill SA agrees to</u>:

1. Supply one agitator with motor for blending the composite flours. The agitator shall have sufficient capacity to assure complete and uniform blending of the composite flours on a continuous basis and at the rate of 12 metric tons per 24 hours.

2. Install all the new equipment provided by DGNT within one month of receipt of all items, and to provide all the necessary auxillary equipment including decking, elevators, screw conveyers, spouting, hoppers, electrical outlets and wiring in order to achieve an operating composite flour mill.

3. Have available appropriate weight scales to allow frequent checking of feeder flow rates.

4. Supply separate means for uniformly blending equal amounts of defatted soy flour and another flour (corn or rice or quinoa) to provide up to 1000 pounds of the blend within a 24-hour period.

5. Operate the mill for demonstration and production of composite flours only as agreed between DGNT and La Inglesa. Provide up to 18 hours of demonstration operation. Provide ample operating time to produce 12 metric tons of composite flour. Provide the bread-type wheat during such operations for which La Inglesa will be reimbursed at cost by DGNT or others as arranged by DGNT. The total composite flours produced will be the property of DGNT or others as arranged by DGNT. DGNT will determine the utilization or disposal of the composite flours.

6. Provide cotton bags for packaging the composite flours for which DGNT will reimburse La Inglesa at cost. Provide clean, safe and secure storage for the products until they can be shipped to the ultimate user but no longer than the end of the Project, "Improving the Nutritional Quality of Wheat Foods."

Signatories:

By the affixing of signatures to this document on this date ____________ 1979, DGNT and La Inglesa Flour Mill SA agreed to carry out the terms of the agreement as described above.

____
La Inglesa Flour Mill, S.A.

____
Director General
Direccion General de
Normas y Tecnologia
Ministerio de Industria,
Comercio y Turismo

Appendix B-16

COST ESTIMATES FOR EQUIPMENT NECESSARY TO CREATE A COMPOSITE FLOUR CAPABILITY AT EACH OF THE 17 FLOUR MILLS IN BOLIVIA

Allan D. Shepherd and David A. Fellers
Western Regional Research Center
U. S. Department of Agriculture
Albany, California 94710

MARCH 1981

SUMMARY

Equipment Cost (1981)	$US 236,303
Ocean freight to Matarani (1981)	$US 15,000
Land freight in South America	not estimated
Installation costs	not estimated

Appendix B-16

CONTENTS

I. Experience at Harinera La Inglesa SRL, La Paz

II. Basic Process and Type of Equipment Chosen For This Estimate

III. Equipment cost estimates for all mills

IV. Ocean Freight

V. Other costs necessary but not estimated

VI. Duplication of equipment - potential for reduction in costs below estimates

I. Experience at Harinera La Inglesa SRL, La Paz, Bolivia

In order to demonstrate the technical feasibility of manufacturing composite flours in Bolivia, agreement was reached between La Inglesa, Direccion General de Normas y Tecnologia, and USAID in 1979 to modify the La Inglesa wheat flour mill. This was a small mill of 10 MT wheat grinding capacity per 24 hours. The modifications were completed in August 1980 and successful production runs were carried out in September 1980 where composite flours containing from 5 to 25% non-wheat flours were manufactured. The cost of this mill modification was $US 14,526 and is described in Table I. Subsequently, this mill was upgraded to 18 MT per 24 hours but the composite flour equipment is still appropriate for the mill.

TABLE I.

Costs to modify Harinera La Inglesa flour mill at La Paz, Bolivia to provide a commercial composite flour capability. Mill capacity was 10 MT wheat per 24 hours.

	Item	Purpose	Cost $US (1979-1980)
1.	Self-powered Gravimetric Feeder, Series A619, Size No. 1[a]	Provide a uniform and constant rate of wheat flow to the mill.	1,305
2.	Micro-Feeder Model A-378[a]	Feed very small quantities of bread improvers into the wheat flour.	2,587
3.	Macro-Feeder with add-on Hopper, Series 32-055 SCR[a]	Feed non-wheat flour into the wheat flour at a rate of up to 25% wheat flour substitution	5,940
4.	Mixer/Blender with motor (Rotating horizontal cylinder with counter rotating beaters), Conveying elevator and miscellaneous pulleys, axles and electrical items	Provide a uniform blending of bread improvers and non-wheat flours with the wheat flour.	4,186
5.	Air transport of items 1, 2 and 3 from USA to La Paz (US Government Carrier).	Transport	508
6.	Installation		Company Engineers; no-estimate
		Total	$US 14,526

a. Manufacturer: Wallace and Tiernan; Division of Pennwalt Corporation; Belleville, New Jersey. Cost includes transportation within the USA to the air terminal.

II. Basic Process and Type Equipment Chosen for This Estimate

The requirements for composite flour equipment have been established by the National Plan of Implementation for Composite Flours adopted by the Ministry of Industry and Commerce, February 9, 1981. The plan is based on the present availability in Bolivia of a 50 MT per 24 hours manufacturing capacity of partially gelatinized corn flour, and the future annual availability of 12,000 MT food grade defatted soy flour (one year from decision to modify the solvent extraction soy processing plant; cost: approximately $US 750,000). The three phases of the plan are: (1) Require all pasta to be manufactured with 10 to 25% of partially gelatinized corn flour, (2) Require all pasta to be manufactured with 10 to 25% partially gelatinized corn flour and 5% defatted soy flour, (3) Require all wheat flour to be fortified with 5% defatted soy flour and with the bread improver ascorbic acid at the wheat flour mills. In phase three, pasta manufacturers would purchase the soy fortified wheat flour from millers and add 10 to 25% partially gelatinized corn flour for manufacture of pastas. Phase three creates the requirements for composite flour equipment at each flour mill to add soy flour and bread improver and thoroughly blend.

TABLE 2 provides a schematic diagram of the composite flour process at each mill. The four pieces of equipment required are: (1) Device to uniformly meter the wheat to the mill (Gravimetric Feeder), (2) A Micro-Feeder to add small ammounts of ascorbic acid bread improver to the wheat flour, (3) A Macro-Feeder to add 5% soy flour to the wheat flour, and (4) A Blender to uniformly mix all the ingredients. The Gravimetric Feeder is needed to insure a constant production rate of flour and therefore, constant feed rates by the Micro- and Macro-feeders. The specific pieces of equipment selected are described below.

1. Self-Powered Gravimetric Feeders, Series A619 offered by Wallace and Tiernan, Division of Pennwalt Corporation, are suggested. The first four sizes of six available will cover the range of flour mill sizes in Bolivia.

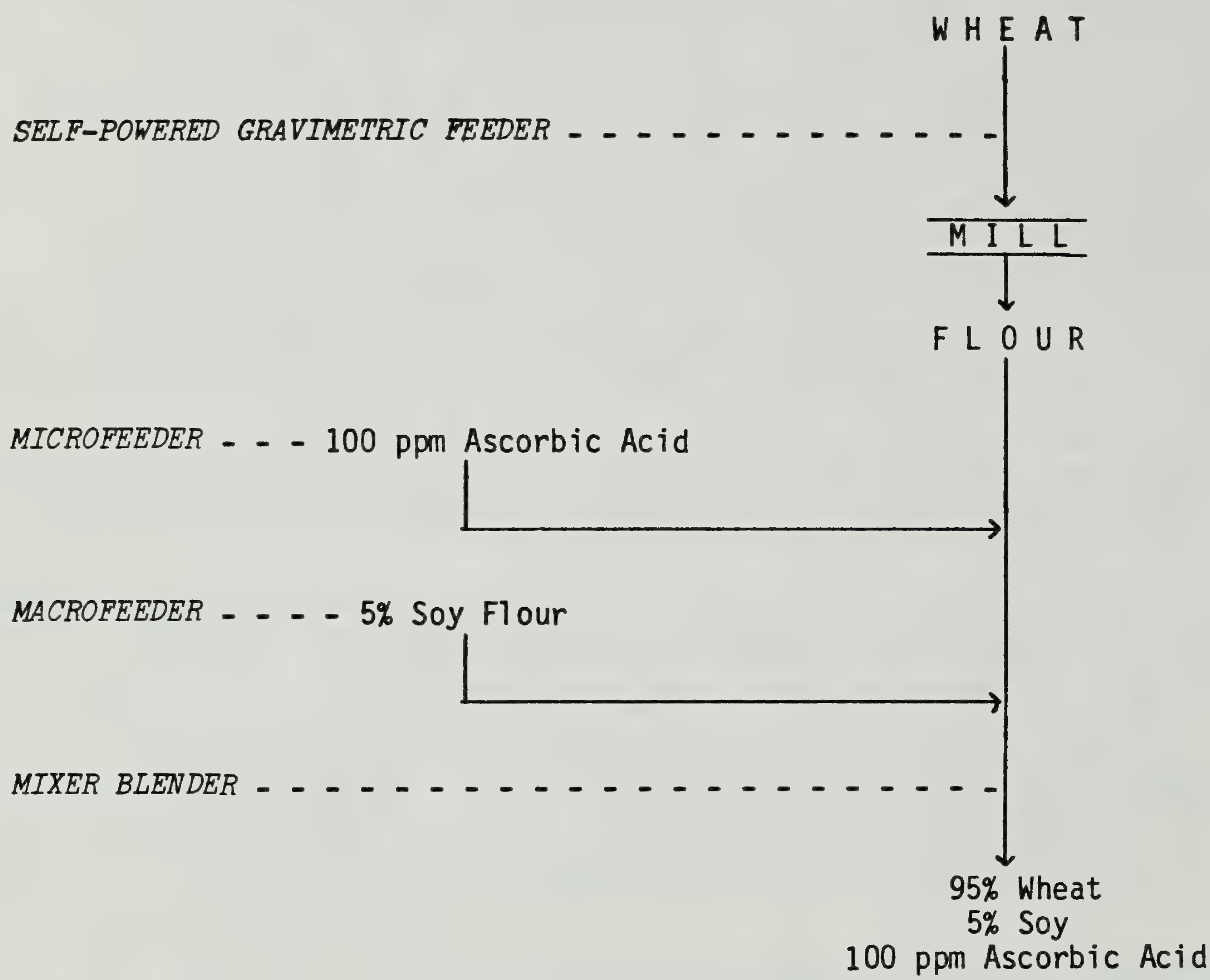
Size	lbs. Wheat Per Minute	MT Wheat Per 24 hours	Price,* $US
1	5-50	3.3-33	1,702
2	20-200	13.0-130	1,752
3	40-400	26.0-260	1,805
4	60-600	40.0-400	1,855

*Complete with shut-off gate and sampling valve

2. Micro-Feeder. A Volumetric Feeder A-378 manufactured by Wallace and Tiernan, Division of Pennwalt Corporation, has been selected. It will serve for each of the flour mills because its capacity is variable over a wide range. Price of the Unit with discharge hopper and stand is quoted at $US 3,700 Febraury 1981.

Appendix B-16

TABLE 2



3. Macro-Feeder. A Controlled Volumetric Feeder, Series 32-055 SCR, manufactured by Wallace and Tiernan, Division of Pennwalt Corporation, has been selected. The two larger screw sizes, 2-1/2 inch unit and 4 inch will provide adequate range for all wheat mills. The basic feeder has 1.6 cubic feet of hopper capacity. The cost is $US 4,690 for the 2-1/2 inch unit and $ US 4,835 for the 4 inch. Three sizes of add-on hoppers may be mounted on the feeders directly: 4.5, 10.0 and 20.1 cubic feet. Above the 20.1 cubic feet capacity , or 1,000 lbs. total weight on the stand, would require additional support. Prices in 304 stainless steel with hopper cover and screen are $US 1,480, $US 1,770 and $US 2,554 respectively. In the estimate, hopper size has been selected to provide a minimum of 4 hours operating reserve of soy flour where possible. For a number of the larger mills, however, this was not possible because of the 1,000 lb weight limit on the feeder stand. For example, for the largest mill, 300MT/24 hours, the largest 20.1 cubic feet hopper only provides a 0.6 hour soy flour reserve. A hopper or bin supported other than on the feeder itself might have to be provided for this mill.

4. Blender. A Cut-and-Folded Flight Screw Conveyor offered by Bay City Iron Works, Oakland, California, is suggested. Availability of different screw diameters and lengths allows for selection for differing production rates.

Diameter of screw in inches	Length of Screw in feet	Capacity in cubic feet per hour**	Price* $US
6	10	20-45	2,039
9	10	45-145	2,083
12	12	145-320	2,450
16	12	320-650	2,878

*Includes a (1) horsepower motor and gear reduction box.
**One cubic foot equals 35 lbs. of wheat flour.

Capacity of a specific screw is adjusted by use of belts and pulleys over a rpm range of 30 to 100.

III. Equipment Cost Estimates for All Mills

TABLE 3 provides a list of flour mills and their capacity and location.

TABLE 4 provides the equipment costs for each mill assuming none of the composite flour equipment is currently available on site. The total cost estimate for equipment is $US 236,303; price quotes February 1981.

IV. Ocean Freight

TABLE 5 provides weights, shipping weights and shipping volumes of the various pieces of equipment. Ocean freight from New York to Matarani, Peru for machinery is $US 309 per 2,000 lbs. or 40 cubic feet whichever generates the most revenue. Based on the assumption that all equipment described in Table 4 is to be shipped, this would require approximately 25,000 lbs. or 1,900 cubic feet and would cost approximately $US 15,000. Rail shipment from Matarani to a Bolivian destination remains to be calculated.

V. Other Costs Necessary But Not Estimated

1. Land freight in South America
2. Import licenses and duty
3. Installation costs

VI. Duplication of Equipment; Potential for Reduction In Cost Below Estimate

It is likely that several mills in Bolivia are already equipped with satisfactory devices for metering wheat to the mill and micro-feeders. As a result of a questionaire issued by the ADIM (Miller's Association) at the request of USAID to all millers, it was learned that the Andino Mill has a micro-feeder and that Ferrari Ghezzi has an old macro-feeder and blender. Unfortunately, the response to the questionaire was incomplete. It is estimated, however, that probably half the mills already have satisfactory wheat metering devices and a quarter of the mills have micro-feeders. If this is the case, the composite flour equipment cost could be reduced by about $US 29,000. In addition, if Rocamador closes its old mill at Potosii (Mill No. 6) an additional reduction of $13,945 would be indicated.

TABLE 3

Flour Mills; Their Locations and Wheat Grinding Capacity

Mill No.*	Name of Mill	Location	Capacity MT/24 Hours
1	IMBA	Cochabamba	10
2	La Inglesa	La Paz	18
3	SIDS	Sucre	20
4	Chapaco	Tarija	20
5	Dolffa	Oruro	21
6	Rocamador	Potosi	25
7	El Progreso	La Paz	25
8	San Luis	Cochabamba	50
9	Rocamador	Potosi	70
10	CMB	La Paz	100
11	SIMSA	La Paz	100
12	Rio Grande	Santa Cruz	135
13	CMB	Cochabamba	135
14	Modelo	Santa Cruz	150
15	CICO	Oruro	180
16	Ferrari Ghezzi	Oruro	185
17	Andino	La Paz	300

*These mill numbers are used in TABLE 4.

TABLE 4

Composite Flour Equipment Costs

Mill**	Wheat Capacity Per 24 HOURS	Total Equip. Cost $US	Self-Powered Gravimetric Feeder		Micro Feeder $US	Macro-Feeder		Add-on Hopper (Macro-Feeder)			Blendor	
			Size	$US		Screw in.	$US	Capacity Cu. feet	Hrs. op. w/5% soy*	$US	Screw in.	$US
1	10	13,611	1	1,702	3,700	2-1/2	4,690	4.5	5.8	1,480	6	2,039
2	18	***										
3	20	13,901	1	1,702	3,700	2-1/2	4,690	10.0	5.5	1,770	6	2,039
4	20	13,901	1	1,702	3,700	2-1/2	4,690	10.0	5.5	1,770	6	2,039
5	21	13,901	1	1,702	3,700	2-1/2	4,690	10.0	5.5	1,770	6	2,039
6	25	13,945	1	1,702	3,700	2-1/2	4,690	10.0	4.4	1,770	9	2,083
7	25	13,945	1	1,702	3,700	2-1/2	4,690	10.0	4.4	1,770	9	2,083
8	50	14,784	2	1,752	3,700	2-1/2	4,690	20.1	3.6	2,559	9	2,083
9	70	14,929	2	1,752	3,700	4	4,835	20.1	2.5	2,559	9	2,083
10	100	14,929	2	1,752	3,700	4	4,835	20.1	1.8	2,559	9	2,083
11	100	14,929	2	1,752	3,700	4	4,835	20.1	1.8	2,559	9	2,083
12	135	15,349	3	1,805	3,700	4	4,835	20.1	1.3	2,559	12	2,450
13	135	15,349	3	1,805	3,700	4	4,835	20.1	1.3	2,559	12	2,450
14	150	15,349	3	1,805	3,700	4	4,835	20.1	1.2	2,559	12	2,450
15	180	15,827	4	1,855	3,700	4	4,835	20.1	1.0	2,559	16	2,878
16	185	15,827	4	1,855	3,700	4	4,835	20.1	1.0	2,559	16	2,878
17	300	15,827	4	1,855	3,700	4	4,835	20.1	0.6	2,559	16	2,878
		236,303		28,200	59,200		76,345			35,920		36,638

*Hours of operation adding 5% soy flour
**See Table 3 for name and location of mill.
*** completed in 1980

TABLE 5

Weights, Shipping Weights, and Shipping Volumes for
Composite Flour Equipment

Item	Equipment Weight, lbs.	Shipping Weight, lbs.	Shipping Volumes Cubic Feet
Self-Powered Gravimetric Feeders Series 619:			
Size 1	60	100	5
Size 2	60	100	5
Size 3	60	100	5
Size 4	60	100	5
Micro Feeder: Volumetric A-378	130	270	25
Macro Feeder: Volumetric Series 32-055 2-1/2 inch or 4 inch	210	300	20
Add-on Hopper Capacity for Macro-Feeder:			
4.5 cubic feet	40	100	10[1]
10.0 cubic feet	100	200	27[1]
20.1 cubic feet (2 parts)	145	300	47[1]
Cut-and-Folded Flight Screw Conveyer with motor and gear box			
Size 6 inch	435	515	13
Size 9 inch	535	635	18
Size 12 inch	735	885	33
Size 16 inch	1085	1285	51

1. Rectangular box containing cone shaped hopper; other items might be packaged in the same container.

Appendix B-17

ASCORBIC ACID DETERMINATION IN WHEAT FLOUR

David A. Fellers
WRRC/AID Wheat Fortification Project

June 10, 1980

Reference: Chemical Analysis of Foods and Food Products. 1951. M.B. Jacobs. D. Van Nostrand Company, New York. pp 724-734.

Basic Problem: It is proposed to add 50-100ppm ascorbic acid (AA) as an oxidant (dehydroascorbic acid is the active oxidant) to composite flours in Bolivia to improve baking performance. A test is needed to be able to determine the level of AA in the flour and its uniformity of blending with the flour. A test giving plus or minus 10% accuracy is adequate. The test must be useable on wheat flour of up to 85% extraction that contain any of the following ingredients: 5% defatted soy flour, 5% partially gelatinized corn flour, 0.2% sodium stearoyl lactylate (SSL), 22 ppm fortification iron (reduced iron or ferrous sulfate).

Proposed Method:

1. A 150-250 gram sample of flour is taken from the flour stream at the mill bag-off or from a bag of finished flour.

2. Thoroughly blend sample in a one liter capped jar.

3. Weigh a 5 ± 0.1 gram subsample in a 100ml beaker.

4. Disperse flour in 10 ml of 95% ethanol.

5. Add 10 ml water containing 84mg of sodium bicarbonate ($NaHCO_3$) per 200 ml.

6. Titrate to a light blue end-point with 2-6 dichlorobenzenoneindophenol (DCBIP) solution. 25 mg DCBIP dissolved in 200 ml water containing 42 mg $NaHCO_3$. Dye discoloration is not instanteous; the final light blue color should be retained after thorough mixing and persist at least several minutes. The light blue color is more obvious in the supernatant as the flour settles. Use distilled water to wash down the sides of the beaker as necessary. The DCBIP dye is blue when alkaline, red when acid and colorless when reduced.

   Calculations: Wheat flour blanks ranged in the area of 0.2 to 1.0 ml dye solution but average 0.4 ml in a series of flours including 2 Bolivian flours.

$$\text{ppm Ascorbic Acid in 5 grams flour} = \frac{\text{ml dye} - 0.4}{0.081}$$

(based on 2.025 mg DCBIP to titrate 1 mg AA; see section on effect of SSL, etc.)

Effects of SSL, Soy, and Corn:

200 mg Ascorbic Acid (AA) was well mixed with 9.8 grams of wheat flour to yield the AA premix. The following samples were prepared each containing 200 ppm AA or 1 mg Ascorbic Acid in 5 grams of final mix:

1. 1 g premix
   99 g flour
2. 1 g premix
   5 g defatted soy
   94 g flour
3. 1 g premix
   5 g pregel corn
   94 g flour
4. 1 g premix
   5 g defatted soy
   5 g pregel corn
   89 g flour
5. 1 g premix
   150 mg SSL
   99 g flour
6. 1 g premix
   150 mg SSL
   5 g defatted soy
   94 g flour
7. 1 g premix
   150 mg SSL
   5 g pregel corn
   94 g flour
8. 1 g premix
   150 mg SSL
   5 g deffated soy
   5 g pregel corn
   89 g flour

5 gram samples (containing 1 mg AA) were titrated with DCBIP (25 mg/200 ml) yielding the following results:

Sample 1	16.4 ml DCBIP dye solution
2	16.4
3	16.9
4	16.5
5	16.0
6	16.8
7	16.4
8	17.1
Ave.	16.6
control Flour	0.4
	16.2 = 2.025 mg DCBIP

The data does not show any consistent effect by any of the ingredients on the AA titration. The method appears to meet the requirements established.

Effect of Potassium Bromate:

Sample 1 above was wetted with ethanol and $NaHCO_3$ (-water) and 60 ppm $KBrO_3$ added (in solution). The sample was titrated with DCBIP solution yielding 16.0 ml. The presence of $KBrO_3$ had little or no effect on the Ascorbic Acid titration.

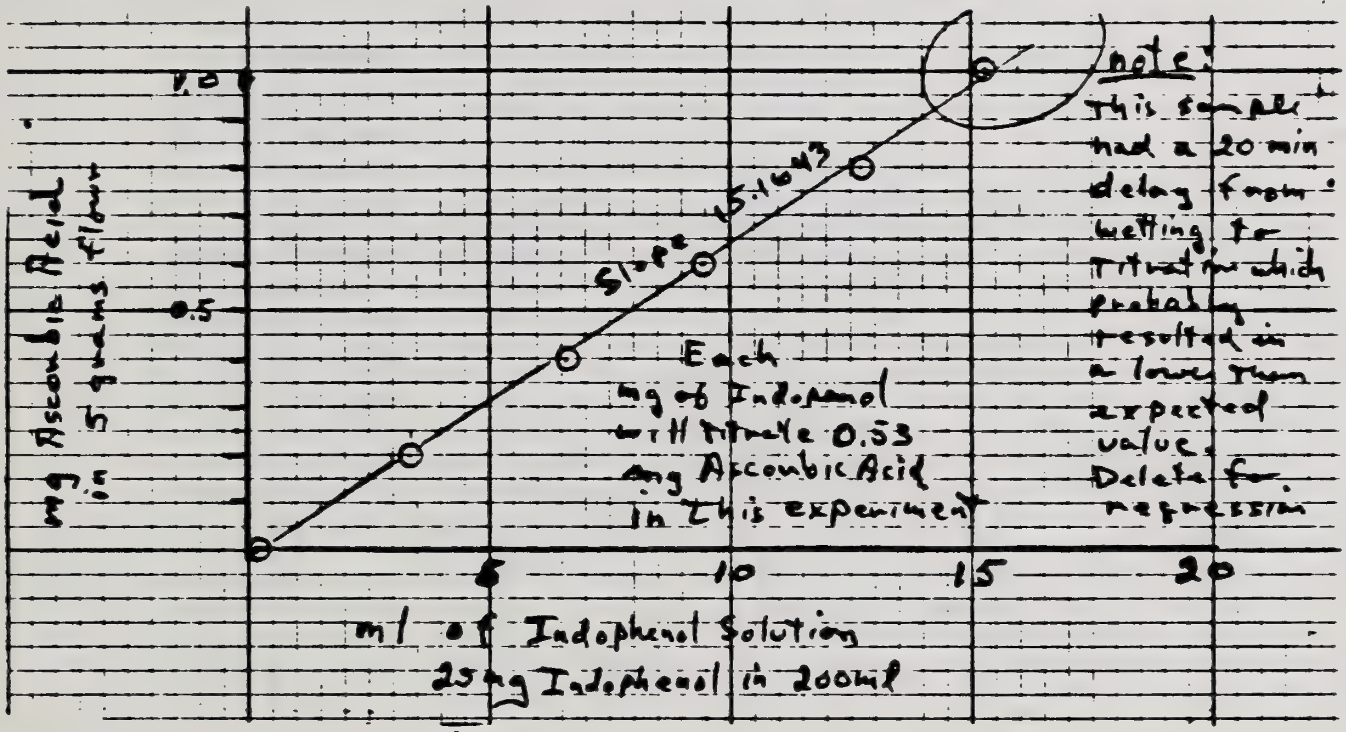
Ascorbic Acid Determination in Wheat Flour Cont'd.

Effect of Concentration:

Using a control flour and sample (1) above, six new samples were prepared as follows:

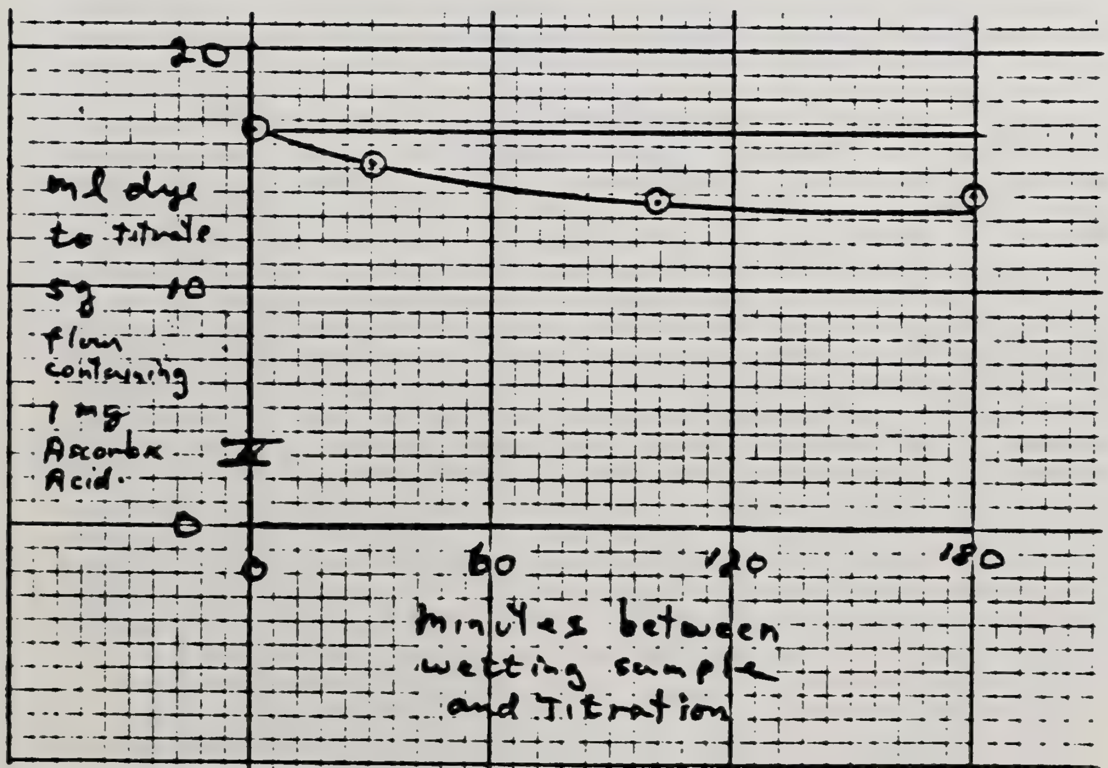
		ml DCBIP dye solution
A =	5 grams control flour	0.25
B	4 g control flour and 1 g sample 1 (0.2 mg AA)	3.35
c	3 g control flour and 2 g sample 1 (0.4 mg AA)	6.60
D	2 g control flour and 3 g sample 1 (0.6 mg AA)	9.45
E	1 g control flour and 4 g sample 1 (0.8 mg AA)	12.70
F	5 g sample 1 (1.0 mg AA)	15.30

Results were plotted below and show a good linear relationship,



Effect of Time of Titration:

Four 5 gram samples of sample (1) above were prepared, the ethanol added and the $NaHCO_3$-water added. The samples were then titrated at 0, 30, 100 and 180 minutes. The results were 16.6 ml, 15.2, 13.8 and 14.0. These results indicate the wetting of flour initiates a reaction resulting in loss of ascorbic acid. Accordingly, the flour should be titrated immediately following wetting.

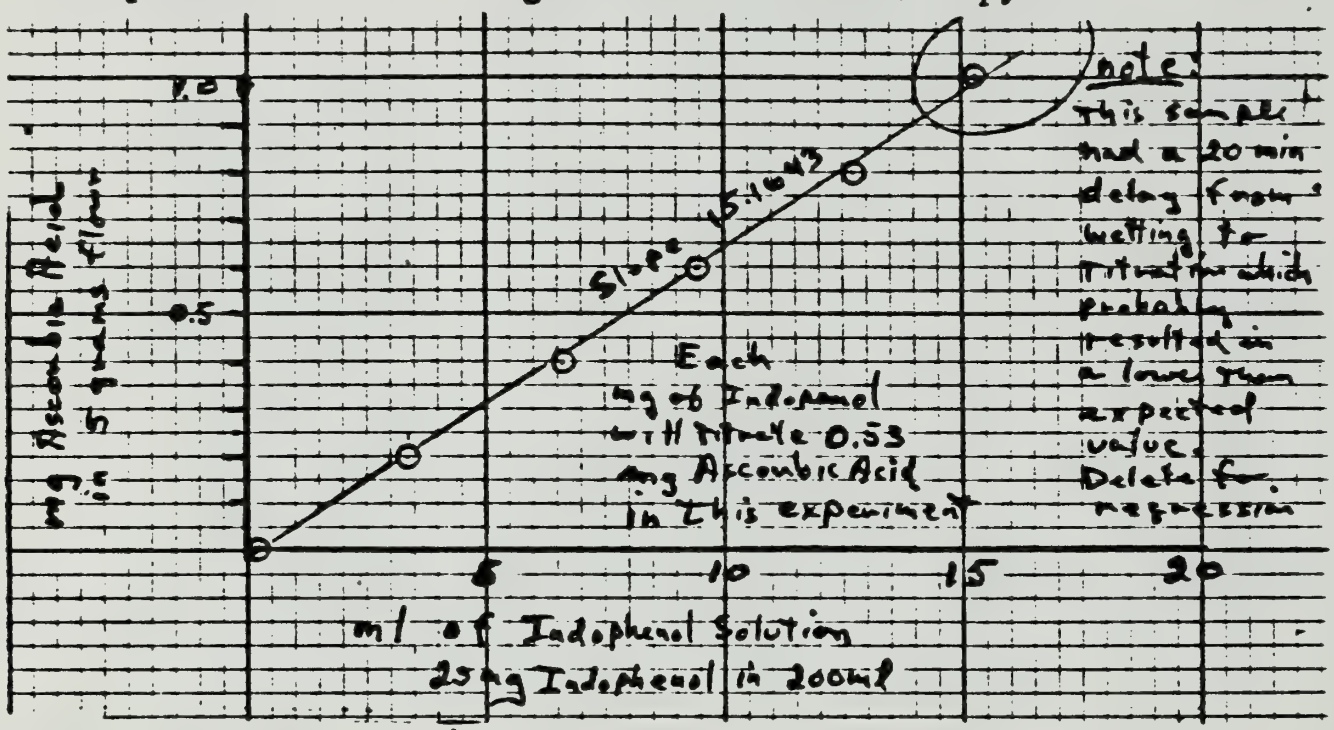


Ascorbic Acid Determination in Wheat Flour Cont'd.

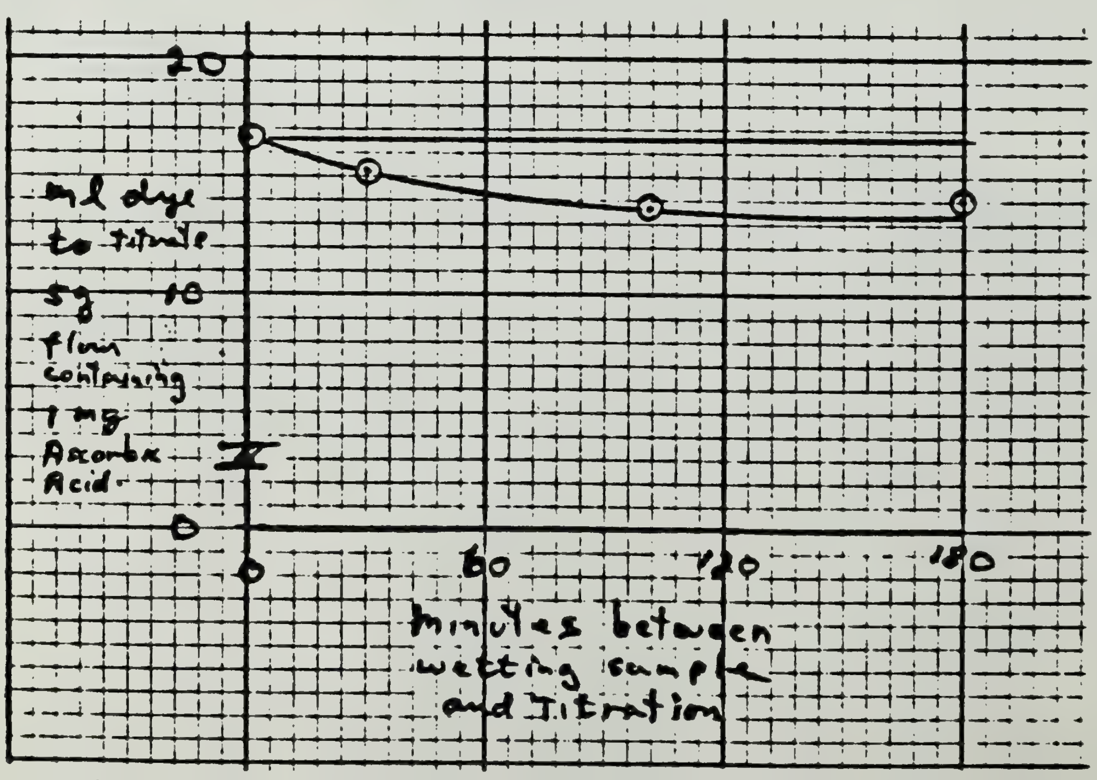
Effect of Concentration:
Using a control flour and sample (1) above, six new samples were prepared as follows:

		ml DCBIP dye solution
A =	5 grams control flour	0.25
B	4 g control flour and 1 g sample 1 (0.2 mg AA)	3.35
C	3 g control flour and 2 g sample 1 (0.4 mg AA)	6.60
D	2 g control flour and 3 g sample 1 (0.6 mg AA)	9.45
E	1 g control flour and 4 g sample 1 (0.8 mg AA)	12.70
F	5 g sample 1 (1.0 mg AA)	15.30

Results were plotted below and show a good linear relationship,



Effect of Time of Titration:
Four 5 gram samples of sample (1) above were prepared, the ethanol added and the $NaHCO_3$-water added. The samples were then titrated at 0, 30, 100 and 180 minutes. The results were 16.6 ml, 15.2, 13.8 and 14.0. These results indicate the wetting of flour initiates a reaction resulting in loss of ascorbic acid. Accordingly, the flour should be titrated immediately following wetting.



COMPOSITE FLOURS FOR BREADMAKING IN BOLIVIA

TECHNICAL ASPECTS

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Appendix B-18 of Final Report

Improving the Nutritional Value of Wheat Foods

Agency for International Development

PASA AG/DS 231-11-76

APPENDIX B-18

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INTRODUCTION

This report describes baking activities carried out over a three year period as part of a US AID Participating Agency Service Agreement (PASA) with USDA, Western Regional Research Center (WRRC), Albany, California. The PASA, "Improving the Nutritional Value of Wheat Foods", surveyed several developing countries, visiting some to assess their potential for protein fortification of wheat-based foods. All aspects of the project are detailed in the Final Report, dated September 30, 1981.

In 1977, an agreement was reached with the Government of Bolivia to pursue co-operative studies on composite flours using domestic non-wheat flours with the imported and domestic wheat supply. The WRRC Baking Technologist, Maura M. Bean, worked with scientists in the Direccion General de Normas Y Tecnologia (DGNT) in the Ministerio de Industria, Comercio Y Turismo (MICT) from 1978 to 1980, during which time several activities were carried out.

Baking laboratory equipment was purchased, shipped, and installed in the DGNT laboratory in La Paz. Laboratory scientists were trained in its use and baking tests were conducted on a variety of composite flours using formulas and baking procedures common in Bolivia. The tests were extended to commercial bakeries using laboratory prepared blends. Ultimately, commercially prepared flour blends were tested in a series of trials in mechanized and artisan bakeries located in three geographically different regions throughout the country. During these activities, the DGNT scientists and the WRRC baking technologist enjoyed a close working relationship with the local bakers associations, in each of the three areas visited: La Paz, Cochabamba and Santa Cruz. The bakers were introduced to composite flour technology and to the usefulness of a variety of dough improvers for the most successful products.

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COMMERCIAL BAKERIES

General

Most bread in Bolivia is baked as small piece goods (rolls) of various sizes, directly on a hearth or on metal trays placed on a hearth. Full size breads (French type - Pan Frances) are also baked in the same manner. A few large bakeries produce limited quantities of pan bread for slicing (Pan Molde).

With the exception of about 6 large bakeries producing a variety of baked products, most of the several thousand bakeries in Bolivia are family operated shops. Many are small, hand shops using 1 or 2 quintales[a] of flour per day with all operations by hand. These are referred to in this report as "artisan" shops. The smallest are household operations whereby dough pieces are made up, taken to a neighborhood oven for bake-off and then sold in a store fronting on the family quarters.

Probably the largest volume of bread products is produced in hundreds of medium sized bakeries with various levels of mechanization. They may use 5 to 25 quintales of flour per day and are located in large towns and cities throughout the country. The owner/operators of these shops form the nucleus for the very active national and local bakers' associations. These groups were a major contact for this project. Most of this report will deal with activities in these medium sized bakeries referred to as "mechanized" shops.

Labor

The owner and family perform much of the work in the bakery which is usually adjacent to, and sometimes part of, the family living area. When helpers are used their pay is usually geared to the number of sacks of flour processed and to their level of responsibility in production.

Ovens

Typically, bakeries are one large room with a brick or metal hearth oven located along one wall and having capacity for the marraqueta yield from 1/2 to one quintal of flour. Some have 2 ovens if production warrants. Brick ovens are kerosene-fired directly into the hearth for several minutes before baking. Depending on heat retention, baking proceeds for several hours until the oven has cooled and needs re-firing. In more primitive artisan operations, a wood fire is built directly on the hearth of beehive ovens and pushed to one side to maintain heat during baking. Metallic hearth ovens often have a separate oil, gas or wood-fired chamber with pipes directing heat to ovens. Some are equipped with steam generators which deliver a controlled amount of moisture to each bake. By contrast, the brick hearth ovens have minimum venting and depend on moisture accumulation during baking. Crust color becomes richer from the first to last batch.

[a] One quintal is 100 pounds or 45.359 Kg.

Mixers

The most common type of dough mixer in mechanized Bolivian bakeries is the slow-mixing SIAM-UTIL. Two sizes are common. The smaller size mixes doughs from 1/2 to 2 quintales of flour and the larger holds up to 5 quintales. The bowl rotates at 4 rpm. Mixing is provided by a double hook which turns the dough over 10 times per bowl revolution. This works each portion of dough 4 times every minute. A stationary scraper continually insures cleaning the dough from the walls of the bowl. Dough mixing times range from 15 to 40 minutes. While blending is efficient, dough development is negligible even after 40 minutes. Additional development is provided by a dough brake (sobadora) or by hand kneading, usually after fermentation. A few bakeries have mixers equipped with a more efficiently designed agitator and more rapid bowl rotation, resulting in improved dough development in less time. All are of the open bowl design.

As Bolivian bakers become more exposed to projects such as this and visit other countries, they are developing a keen interest in upgrading their equipment and processing methods. During the final bakery trials of this project, one baker was sharing advertising on a new Brazilian mixer she had purchased. This mixer develops doughs faster and more efficiently resulting in an increase in her bakery's output, sufficient to pay for the mixer in about 2 years.

Fermentation

Doughs are fermented in stationary wooden troughs often large enough to hold several doughs from successive batches. Some bakers have, in addition, small troughs on wheels for individual doughs. The last dough of the night may be fermented in the mixer. Doughs are covered with plastic and/or cotton sacks to maintain heat and humidity. Doughs may be punched down (degassed) after doubling, then provided additional fermentation before dough make-up. Water is heated to achieve dough temperatures between 25 and 35°C, but ambient temperature is often the only subsequent control. This may be over 40° in the tropics and under 20° in the altiplano. Some bakers have built chambers at one side of their ovens to serve as fermentation rooms.

Dough Brake (Sobadora)

Bakers who produce specialty breads other than marraquetas, routinely use a dough brake to provide gluten development to undermixed doughs. From 5 to 15 Kg. of dough are passed through rapidly revolving rollers several times providing a sheeting action. By judicious setting of roller clearances, a baker can progressively develop a dough by causing tearing action at close settings, folding the dough piece after each pass, and eventually opening the rolls to produce a smooth, well developed dough after 30 to 40 passes. Some specialty doughs are transferred manually (no conveyor belt) directly from the dough brake to the make-up table as sheeted doughs of uniform thickness. They may or may not be layered with fat. They are cut in squares or diamonds as desired. Because of the added time and labor costs, bakers are reluctant to use the dough

brake for marraquetas, a price-controlled bread. It should be noted that this type of dough brake is not allowed in the U.S. because of the lack of appropriate safety features in its operation.

Dough Dividers

Except for the sheeted and cut doughs noted above, weighed dough pieces are cut into predetermined sizes in hand-operated bun dividers. For example, 3000g of dough are cut into 30 pieces of 100g each for marraquetas. Without a bun divider, marraqueta dough pieces must be weighed individually to conform to legal baked weights. This is probably the most time-consuming operation of the entire production process. The skill of the baker and helpers in estimating dough weights correctly and rapidly is significant in determining the total daily production and hence income.

Make-up, Baking and Distribution

Marraquetas and other French-style hearth breads are formed by hand or processed through a sheeter-molder which yields a typical elongated roll with tapered ends. Finished dough pieces are proofed on cotton cloth placed on boards or trays. Proof-time is determined by feel of the doughs by the experienced baker. Doughs are manually transferred to trays or peels for placement on oven hearth. Transfer is rapid and not very gentle (See p. 11-12) for further discussion of shock abuse and dough strengtheners). Baked breads are transferred directly from the oven to large baskets and sold in bulk quantities for resale by small vendors. The consumer purchases individual pieces in the marketplace or in stores.

One aspect of this project was to develop research and development facilities in a Government of Bolivia laboratory that could examine technical aspects of composite flour concepts for application under Bolivian conditions. The next section discusses the capacity developed.

TEST BAKING LABORATORY IN BOLIVIA

In November-December 1977, appropriate test baking equipment was selected and purchased in the United States for delivery to WRRC for final crating and shipment to La Paz, Bolivia. Crates were shipped in March 1978 by surface to Miami, Florida, from there via Lloyd Aero Boliviano (LAB). They arrived in La Paz in April 1978. They were released from customs and installed in a new laboratory facility at DGNT by February 1979.

Equipment

The equipment selected was similar to that used in test baking facilities in the United States. This provided the DGNT laboratory with a technical capability for scientific baking experimentation, results of which could be compared with overseas laboratories. At the same time, the equipment was

adaptable to conditions approximating baking systems within Bolivia, by judicious changes in procedures, temperatures, and humidity conditions. The equipment chosen also complimented that already on hand in the DGNT facility, namely a Brabender farinograph, extensograph, amylograph, roller mill jr., and a moisture tester. The U.S. equipment was donated through USAID to the Government of Bolivia. A description follows:

1) Dough Mixer, Hobart A-200, equipped with 12 and 20 qt. bowls, whip, flat beaters and dough hooks and a McDuffee bowl and fork.
2) Fermentation cabinet, 2/3 size, National Mfg. Co.
3) Dough sheeter and molder, for pup and pound doughs, National Mfg. Co.
4) Loaf Volumeters, pup and pound sizes, National Mfg. Co.
5) Balance, Toledo Computagram, 5 Kg capacity, Toledo Scale Co.
6) Reel Oven, one pan wide, 4 revolving shelves, equipped with a steam generator, Bakers Equipment/Winkler.
7) Miscellaneous: bun and loaf pans (pup and pound), hygrometer, timers, thermometers, spatulas.

Where applicable, electrical devices were obtained to operate on 50 cycle current. The equipment was put in operation in February 1979. Because of laboratory plumbing problems, the steam generator was not used beyond the initial start-up. All other items proved satisfactory for a laboratory facility.

Baking Methods

Recognizing the predominance of hearth bread and rolls in the Bolivian marketplace, laboratory tests included baking performance in marraqueta-type rolls, the most typical bread in the country. However, in order to obtain laboratory data that could be compared between and among experiments, pan breads were baked from the same batch of dough as used for the marraquetas. Laboratory pan breads included PUP loaves, baked from 150 g of dough and POUND loaves, baked from 560 g of dough. Marraquetas were baked from 80 g of dough for 60 g rolls and from 100 g for 80 g rolls. In this report, loaf volume results are compared for pan breads.

Formulas

The formulas used followed those suggested by bakers for marraquetas. These are lean formula breads, containing flour, sugar, salt, yeast and water. For composite flour trials several dough strengthening agents were used, e.g., oxidizing agents, surfactants and shortening. The range of ingredient levels and the optimums determined for the laboratory tests were as follows:

Standard	Range	Laboratory
Flour Blend	100%	100%
Sugar	1 to 4%	4%
Salt	0.5 to 2.0%	1.5%
Yeast, Compressed	0.5 to 2.0%	2%
Yeast, Active Dry	0.5 to 2.0%	1%
Water	50 to 75%	60 to 67%

Other

Potassium Bromate	20 to 40 ppm
Ascorbic Acid	100 to 150 ppm
Surfactants	0.2 to 0.5%
Shortening	2 to 3%

Experimental laboratory doughs were based on 1000 g of flour or multiples thereof. Bakery trials were most often based on 23 kilograms (1/2 quintal).

Procedures

Heat water to 35 to 40°C.
Compressed yeast: suspend in some of the premeasured water.
Active dry yeast: rehydrate in some of the premeasured water with sugar added, allow to stand 10 minutes to prove.
Dissolve salt and sugar in remaining water.
Mix all ingredients in 12 or 20 quart bowl of Hobart A-200 equipped with a dough hook, 30 seconds on speed 1, then 2 to 10 minutes on speed 2 depending on experimental variables.
Dough temperature off mixer: 23 to 26°C.
Ferment in cabinet set at 30°C, 90% relative humidity for 1 to 4 hours, with intermittent degassing for long fermentation periods.
Scale required dough weights; round up pieces.
Rest in fermentation cabinet 20 to 30 minutes.

For Marraquetas: Scale 80 to 100g pieces, round each by hand.
Rest 20 minutes
Pass through National Sheeter-Molder, adjusted to 3 inch width once at 3/16 inch setting, then at 1/8 inch.
Curl by hand, starting at first end out of sheeter.
Roll on table 10 times exerting gentle pressure with palms of of both hands, moving hands from center to ends of dough to create a thicker center tapering at ends.
Proof on bun pans in fermentation cabinet, usually 40 minutes.
Just prior to baking, slash top surface with a sharp blade.
Bake at 200° to 240°C.

For Pan Breads:	PUP	POUND
Scale and round	150g	560g
Rest	20 min.	30 min.
Sheeter width	3 in.	6 in.
Roll - first setting	9/32 in.	11/32 in.
second setting	3/16 in.	7/32 in.

Curl by hand, starting at first end out of sheeter.
Elongate by applying gentle pressure by hand while rolling on table or between wooden rolls of molder.
Proof to preselected height (usually 1 inch) or to time (30 to 60 minutes).
Bake at 200-240 °C.

Evaluation

The major criteria for judging the products in the laboratory were handling properties of the doughs, and flavor, color, odor and volume of the baked piece. In the bakeries, these factors plus the character (boldness) of the break on top of the marraqueta were the major criteria. This latter characteristic is produced by slashing the dough surface with a razor just prior to baking, thus permitting expansion of the bread at this point. To the baker, a bold, large break with a smooth shred where the dough has stretched, indicated a well-developed dough with optimum oven expansion. To the consumer, it provides appetite appeal. Since these rolls are usually chosen individually from a basket at the point of sale, the character of a well-developed break is a potent sales feature.

LABORATORY TESTS

The technical considerations necessary for making bread type products with wheat-based composite flours must start with the concept that wheat is unique among cereals, in that two of its proteins, glutenin and gliadin, develop a filmy matrix when water is added to it and a dough is mixed. It is this film, called gluten, which holds gas developed by the yeast during fermentation and allows the dough to rise. The strength of this film depends on many factors, including the quantity and quality of these wheat proteins. When non-wheat flours are added to a wheat dough, they, at the very least, immediately dilute the quantity of wheat protein, and thus weaken the total gluten network. Depending on the non-wheat flour, other adverse effects may also occur, and further weaken the dough.

Composite flour technology depends not only on high quality wheat and non-wheat flours, but also on a variety of dough additives which can strengthen the diluted wheat gluten allowing it to carry the non-wheat flour. This section describes the flours and other ingredients used in bread-making in Bolivia and also reports several laboratory tests with dough improvers and the non-wheat flours under consideration for the composite flour blends.

A. Ingredients

All traditional bread ingredients used in these trials had been processed in Bolivia. With the exception of wheat, which is imported, all raw materials were produced in-country.

Wheat Flour

Most of the wheat flour consumed in Bolivia is milled in 17 roller-mills situated throughout the country. Wheat is imported and is typically represented by U.S. Hard No. 2. At the beginning of this project, the legal extraction rate for flour was 72%. In 1979, a new government changed the legal maximum to 76% extraction. Flour is sold in 100 pound cloth bags. One sack is a quintal which weighs 45.359 Kg., usually rounded to 46 Kg for calculating bakers percentages. Proximate analysis of several flours used in this project were as follows:

Flour	Moisture %	Protein* %	Ash* %
A	13.0	11.4	0.57
B	14.0	9.5	0.38
C	13.4	11.7	0.72
D	12.6	14.5	0.79
E	13.2	11.2	0.54
F	11.9	11.3	0.60

*as is, moisture basis. Protein = N X 5.7.

These flours were unbleached and did not contain maturing agents, vitamins, minerals or enzymes.

Salt

Table salt is available in Bolivia in sealed plastic bags in quantities from 100 g to 1 kilogram. It is coarse by comparison with U.S. products. A limited quantity is iodized. In the rural areas of the altiplano and desert regions, salt is available in chunks or pieces as it is dug from the earth. People grind it between stones as needed for bakery and domestic uses.

Sugar

Sugar is commonly packaged in sealed plastic or cotton bags in sizes from 100 g to 100 lbs. It is off-white in color and coarse compared to the U.S. product. Bakers generally use the small packets adding 1 to 4% to marraqueta doughs depending on the yeast level and fermentation time. They add larger quantities to specialty bread doughs (pan surtidos, pan especial) along with fat for a richer, slightly sweet product.

It is interesting to note that Bolivians do not consume highly sweetened baked goods as we do in the U.S. Their preference for less sweet products was demonstrated when a U.S. cookie test was used in laboratory testing (AACC Method 10-50D). It became necessary to reduce the sugar level from 58% of the flour to 34% to produce a product with the level of sugar and sweetness in the Bolivian commercial products.

Yeast

Baker's yeast is produced in one plant, Industrias Venado, S.A., situated in La Paz. Under a franchise with Fleishmann Co., U.S.A., they produce compressed yeast in one-pound cakes and active dry yeast (ADY) packaged in 170 g quantities in foil packets and in larger quantities in rigid bulk containers. The compressed yeast is distributed in La Paz and surrounding areas and in 3 cities within 30 minutes by air from La Paz. All other locations, including Santa Cruz, the second largest city, use active dry yeast. Some La Paz bakers also use ADY by choice.

B. Dough Improvers

General

Worldwide studies on composite flours for yeast-leavened breads have consistently recommended adding various dough strengthening agents to counteract adverse effects contributed by non-wheat flours. Compounds, most often recommended, include oxidizing agents such as potassium bromate, potassium iodate, and ascorbic acid. These can be added at the flour mill. Animal or vegetable fats and oils, added by the baker, have also been shown to contribute dough improver effects. These materials have been in common use for years as improvers for 100% wheat breads, as well for composite flour breads.

A more recent development that provided a powerful thrust to composite flour technology was the demonstration that a variety of materials of the surfactant-type can impart significant strength to wheat flour doughs to maximize their capacity to carry non-wheat flours. Several have been shown to contribute improved dough handling properties as well as improved bread characteristics in products containing a wide range of non-wheat flours. Some of these compounds also improve shelf life of the baked product through their ability to retard crumb staling. Several are powders which can be added by the miller producing the composite blend. All can be added by the baker at dough mixing.

The project reported here was an extention of previous investigations that had demonstrated the feasibility of adding up to 12% soy flour to wheat flour and minimizing or eliminating any adverse effect by the addition of the dough improver, sodium stearoyl-2-lactylate (SSL). During the course of this project, a variety of oxidizing agents and surfactant-type dough conditioners were evaluated under Bolivian conditions.

Bolivian Experience

In the past, Bolivian bakers have not had ready access to oxidizing agents or surfactant-type dough conditioners. That is changing. Since 1979, a line of four products has become available through the company that produces yeast (Industrias Venado, S.A.). These would appear to have been the first such products advertised in the public press in Bolivia for improving breads. They are produced in Brazil and include the following, with descriptions as given on the labels and in the advertising:

PANCEL - powder, gluten improver, vitamins;
PANZIME - powder, enzymatic regulator, diastatic activity;
LACTOPAN - oil, powerful emulsifier,
ANTIMOHO - powder, antimold agent.

The recommended use level at the prices prevailing in 1979 would add approximately 6% to the cost of a quintal of flour if all were used in combination.

While dough improvers were not in common use in Bolivia when our project began, many Bolivian bakers have known of the usefulness of potassium bromate and ascorbic acid. Some have suggested the use of bromate in specialty doughs which are usually sweeter and richer than marraquetas. These doughs are developed on a dough brake (sobadora) after a short fermentation time of one to two hours. Some bakers felt such doughs benefited from the bromate, others felt if they contained bromate they needed the additional development contributed by the dough brake. One of our tasks was to determine if composite flour doughs containing bromate needed additional development beyond that normal to marraqueta production.

Cost

In the initial stages of the project, potassium bromate became the key dough improver necessary to strengthen doughs carrying 5 to 10% non-wheat flours. It was the dough conditioner of choice because it was the least expensive, adding only 0.1% to the cost of a quintal of flour. Ascorbic acid was 2 to 4 times more costly due to a higher usage level and a higher material cost. The surfactant-type dough conditioners were considerably more expensive at the effective use level adding 2 to 3% to the flour cost.

Safety

As the project developed with potassium bromate, some concern was expressed as to it's safety for humans. Copies of reports on toxicity studies conducted in England were made available in English with Spanish translations of summaries. Additional references to FAO Codex standards were supplied along with observations on the long history of use of bromate in the United States and other countries with no adverse effects demonstrated in human health. These studies failed to convince the decision makers in Bolivia as to it's safety at the levels we would be using (20-40 ppm) in the flour. They eventually opted for ascorbic acid at 100 to 150 ppm added at the flour mill, with the surfactant-type dough conditioners to be the choice of the baker.

Function

Dough oxidizing agents, potassium bromate and ascorbic acid, proved effective in counteracting most of the dilution effects of up to 10% non-wheat flour in laboratory tests. However, initial bakery trials showed they did not overcome all the handling shock associated with commercial systems, even the labor intensive systems predominant in Bolivia. Individual dough pieces are often handled 2 to 3 times between make-up and baking. Typically, hand or machine molded doughs are proofed on cloth-covered wooden boards, then transferred to an oven peel, slashed with a razor blade to provide the typical french bread cut, then slid into an oven. Handling is rapid and not gentle. The baker tends to push his/her fingers firmly into the dough while slashing the top with the other hand. When the doughs are slid from the peel onto the hearth of the oven, the movement is sudden, to aid transfer, and many doughs collapse noticeably. This phenomenon was similar to that exhibited by shocked doughs on conveyor belts

in highly mechanized systems. Dough conditioners which impart strength for the mechanized systems also proved helpful in the hand-operated bakery, providing tolerance against abuse and increasing volume potential.

Dough improvers known to complex with proteins during dough mixing, yield their maximum effect in well-developed doughs. In Bolivia this concept is important because many bakeries have slow mixers which do not develop gluten strength to the optimum for maximum performance. Some doughs have additional development by hand kneading or by several passes through the dough brake, usually after fermentation. In general, marraqueta doughs do not receive additional development beyond that imparted by the slow mixer.

To demonstrate the effect of dough development on dough conditioner function, laboratory tests were conducted using a composite flour containing optimum potassium bromate, with and without the dough conditioner, SSL. Doughs were mixed at medium speed in a Hobart A200 equipped with a dough hook. Initial quantity of dough was based on 2000g of flour in a lean marraqueta formula; 1130g of dough was removed at 2, 4, and 8 minutes mix time to provide undermixed, slightly undermixed, and optimum mixed doughs. (Overmixing is not a problem in Bolivia). Results were as follows:

Composite Flour: 5% defatted soy flour, 5% rice flour, 90% wheat flour

Mix time (minutes)	Loaf Volume (cc) 30 ppm bromate		30 ppm bromate 0.3% SSL	
	pound	pup	pound	pup
2 minutes	1700	405	2050	470
4 minutes	1700	405	2550	585
8 minutes	1750	470	2620	675

Loaf volume response to potassium bromate was somewhat improved with dough development, while that to SSL was markedly improved. Without dough development (2 min. mix) the SSL improved volumes over that with bromate alone, demonstrating a significant effectiveness in minimally developed doughs.

SSL Levels

The effectiveness of surfactant-type dough conditioners in successful application of composite flour technology is well-documented worldwide. A major factor limiting applications in developing countries is its cost which can add 2 to 5% to the price of a sack of flour. This increase becomes more significant to the baker of price-controlled products where the additional cost cannot be passed on to the consumer.

Initial experimentation and testing of composite flours in Bolivia assessed dough conditioner response at the 0.5% level, prevelant in U.S. commercial applications and in P.L. 480 soy-fortified flour. In laboratory tests in La Paz at 12,000 ft. elevation above sea level, composite flour marraquetas with 0.5% SSL had such high volumes that they were not acceptable to the consumer. Subsequent studies indicated a level between 0.2 and 0.3% was sufficient with 10% non-wheat flours. Below 0.2%, bread improvements were marginal. Final recommendations suggested at least 0.2% SSL as the most cost effective level of addition. This could be added at the mill with current feeder technology or could be added by the baker at dough mixing.

Crumb Problem

A typical defect exhibited in pan breads in the altiplano area of Bolivia is a weak or torn crumb area of 1 to 2 cm below the top crust and parallel to it. It is similar to crust separation which occurs when excess vacuum is used to depan bread in highly mechanized U.S. systems. It occurs during cooling when the fragile crumb contracts pulling away from the more rigid crust. It is a more common fault in the high altitude regions than in the tropical lowlands. Doughs expand more during baking at 12-13,000 ft. due to the low atmospheric pressure and reach a lower internal temperature (87° to 88° C) limiting heat setting of the protein-starch structure. Both factors contribute to a more delicate crumb with less cohesive strength, thus vulnerable to tearing during the rapid cooling contraction in the high, dry climate.

Experiments with composite flours and dough conditioners indicated that both the non-wheat flours and the dough conditioners markedly improved this problem, essentially eliminating it. Dough oxidizing agents and surfactants presumably acted by strengthening the crumb structure through their interaction with proteins. (Such effects have been documented in world literature in scientific studies on dough improving agents.) When the non-wheat flours were present without the dough conditioners, they also eliminated the torn crumb structure. The reasons were not apparent except that, without the improvers, the non-wheat flours diminished loaf volume. Perhaps the more compact crumb was less vulnerable to tearing.

C. Non-wheat Flours

Soy Flour

At the beginning of this project, food grade soy flour was not commercially available in Bolivia. A major goal was to encourage the establishment of processing facilities that would provide defatted soy flour for composite flours and for other food needs. Another AID-supported project in Cochabamba was developing marketing aspects for whole soy beans. Both projects developed a keen awareness of soy potential in the processors and in the consumers alike.

Soy flours for test baking were prepared in the DGNT laboratory from defatted soybean meal provided by SAO (Sociedad Aceitera del Oriente),

a soy oil processor in Santa Cruz, Bolivia. Flours were prepared by a laboratory method developed during the technical assistance visit of Dr. Walter Wolf of NRRC, a sister laboratory of WRRC, located in Peoria, Illinois. After autoclaving and rollermilling, the flour that passed through a 100 mesh sieve (including coarser fractions remilled) was used for baking. (See Section E of main report for methods and non-baking aspects of the soy flour situation in Bolivia).

During a period of 2 years (1979-1980) three soy flours were produced in the laboratory for test baking. Their proximate compositions were:

	Moisture	Protein[a]	Ash[a]	Fiber[a]	PDI[a]
I March 79	11.25	52.8	7.42	4.20	6
II May 79	9.17	52.8	8.03	2.07	42
III March 80	11.28	56.3	6.85	2.00	

[a] as is moisture basis. Protein = N X 6.25.

Laboratory trials compared baking results of composite flours containing rice, quinoa or soy. These indicated that lower levels of soy flour could be tolerated in a blend to yield bread quality equivalent to 100% wheat flour bread baked without a dough conditioner

Blend	Potassium Bromate	Loaf Volume (cc.) Pound	Pup
100% wheat	None	2040	485
5% Soy	20 ppm	1840	500
10% Rice	20 ppm	1962	492
10% Quinoa	20 ppm	2025	495

Subsequent trials indicated that 30-40 ppm potassium bromate or 100-150 ppm ascorbic acid was necessary for 5 to 6% soy flour when it was the only non-wheat flour in the blend.

Baking tests also compared the DGNT produced soy flour with 3 commercial U.S. defatted soy flours representing a range of toasting treatments as indicated by Protein Dispersibility Index (PDI).

Soy at 6% of blend with 40 ppm bromate	PDI	Pup loaf volume (cc.)	Wheat flour	Pup loaf volume (cc.)
DGNT	42	515	no bromate	460
USA light toast	70-79	530	20 ppm	510
medium toast	35-45	530	40 ppm	670
full toast	9-20	525		

The loaf volume results were essentially similar for all soy flours and indicated a positive response to potassium bromate at the 40 ppm level. The wheat flour, also positive to bromate, was the weakest and lowest protein flour used in this project (Sample B, page 9). Additional tests with stronger wheat flours and Bolivian soy flours in combination with rice or quinoa indicated the need for SSL or another surfactant type dough strengthener with the oxidizing agent. This observation followed with all combinations or single non-wheat flour additions at the 10% level or greater.

Because the hulls are not removed in the initial seed crushing process, the Bolivian soys tended to have a darker color than the U.S. products. The bread crumb was somewhat darker. However, no off flavors were detected in the flours or breads made from the Bolivian soy flours.

Rice Flour

Rice flour is not a commercial product in Bolivia and was produced especially for this project. Initial tests were made on flours prepared in a laboratory roller mill (Brabender Jr.). Two commercial wheat flour mills were subsequently used to produce larger quantities of rice flour. The first tests compared the laboratory product with a commercial U.S. rice flour milled from California short-medium grain rices.

Flour Blend	Pup Loaf Volume, cc		Starch
	No Bromate	40 ppm Bromate	BEPT, est. °C.
10% Bolivian rice flour	470	585	67°
10% U.S. rice flour	490	600	62°
100% wheat flour	555	725	-

The loaf volume differences between rices were not significant. More important was the response to 40 ppm potassium bromate to yield volumes comparable to those obtained with wheat flour baked in the same formula without bromate. The large response for wheat flour alone to bromate (555 to 725 cc) is typical of that found for many wheat flours throughout the world.

The estimated BEPT (Birefringent endpoint temperature) of the starch is noted for the 2 rices because this gelatinization characteristic can be important if large quantities of rice flour are used in composite flour blends. Research at WRRC has shown that rice flours with low gelatinization temperatures (BEPT below 65° C) and low amylose values (below 20%) give soft texture to bread crumb. In the U.S., these characteristics are typically represented by short and medium grain rices which have soft, sticky characteristics when cooked as whole kernels. The U.S. rice tested in Bolivia had these characteristics. These contrast with long grain rices which yield dry, fluffy rice when cooked as kernels. Flours from long grain rices generally have BEPT temperatures above 70°C and amylose values above 20%. They impart a sandy characteristic to the texture of baked products.

The Bolivian rice flour used in these experiments had a BEPT of 67° C., which was intermediate between those commonly found in the U.S., and an amylose content of 24%, similar to U.S., long grain rices. Other Bolivian rices examined had BEPT's of 69°C. In general, Bolivian rices studied were more typical of long grain varieties in kernel length and physicochemical characteristics. Two Bolivian scientists noted a softer, more pleasing character in the crumb of breads containing the U.S. rice flour.

Quinoa Flour

Chenopodium quinoa Willd is the most common species of quinoa (key no a) grown and consumed throughout the high Andean countries. Other Chenopodiacea grow wild but this species is cultivated and apparently has been since ancient times. Seeds have been found in the pre-Inca ruins of Tihuanaco, a 10,000 year old center of culture located near Lake Titicaca at 13,000 feet altitude.

The unique food aspects of quinoa are it's protein content (11 - 14%), high lysine content (6.5% of protein), and extremely small starch granules (about 1 micron diameter), containing about 20% amylose and a BEPT of 55° C. The harvested seeds are small (about 2mm). The germ or embryo is located in an equatorial groove surrounding approximately 3/4 of the seed. A large amount of the total seed protein is located in the germ. The four pericarp layers comprising the seed coat contain significant levels of saponins which must be washed out before cooking to eliminate the bitter taste. Traditionally, washing may involve placing a cloth bag of the seed in a stream of running water overnight or repeated washings with agitation (by hand or machine) until the water no longer foams, indicating the saponins are virtually eliminated. (Of interest, the foamy residue is preferred over synthetic detergents for washing hair and white clothes.) Hulls are removed with the foam. If agitation is severe, germ (and thus protein) is removed also. Some so-called sweet quinoas need less washing because they contain no saponins or saponins that are not bitter. Scientists working in the field believe the sweet quinoas contain saponins but at a very low level. People who have been eating quinoa for centuries have no common disorders which would implicate medically or nutritionally detrimental factors contributed by quinoa.

Baking tests with quinoa were concerned with it's functional effects in wheat-based composite flours and the need for dough additives.

Flour Blend	Pup Loaf Volumes, cc		
	No Bromate	20 ppm	40 ppm
100% Wheat flour	555		725
5% quinoa	515	660	630
10% quinoa	510		585

While there was a decrease in loaf volume of breads with 5 and 10% quinoa, this decrease could be counteracted with potassium bromate added at 20 or 40 ppm to produce breads similar to wheat bread without dough additives. Subsequent commercial trials suggested 10% non-wheat flour blends should have surfactant-type dough conditioners in addition to the oxidizing agent.

Quinoa flours did not seem to present any unusual problems in composite flour breads beyond that expected by the dilution effect. Dough absorption adjustments were minor or non-existant for quinoa additions. The flour was whiter than wheat flour but had a grey cast (compared to yellow in wheat flour). At the 10% level of addition the bread crumb was whiter with slight grey overtone. In final bakery trials, 8% quinoa was used in composite flour blends for the tests in the Altiplano.

COMMERCIAL BAKERY TRIALS

A. Initial Tests, May 1979

The first bakery trials, after initial testing in the DGNT laboratory, were held in mechanized bakeries in a suburb of La Paz and in Santa Cruz, comparing composite flour performance at two altitudes (12,000 feet and 1350 feet) and in two climates (early winter and tropical).

In La Paz, composite flour blends contained soy or soy plus rice or quinoa. In Santa Cruz, soy and rice were tested separately and in combination. Quinoa was omitted because it is not a traditional cereal in the tropical regions. Corn flour had not yet been considered for the project. Blend preparations are given in Table I.

La Paz Highlights

These trials confirmed laboratory tests on the usefulness of 20-30 ppm of potassium bromate in conjunction with 0.3% SSL for production of marraquetas and french breads from composite flours containing 5 to 15% non-wheat flours. The addition of 5% soy flour enhanced crust color such that the baker associated it favorably with the rich golden brown color of breads containing fat. See Table II for details of the commercial trials.

Santa Cruz Highlights

The results (Table III) paralleled those in La Paz with one exception. This was the first commercial trial testing a blend without surfactant type dough conditioners. Blend #3 (Table I) contained 30 ppm potassium bromate in a 10% non-wheat composite flour (5% soy and 5% rice). Marraqueta volumes were only slightly less for this blend than for the baker's 100% wheat flour daily production. Of more concern to the 12 bakers in attendance was the lack of boldness in the break and shred at the cut surface. The same blend with 0.3% SSL (Blend #4) and all the other blends tested had very high volumes and bold, appetizing breaks. They crackled in the hand when gentle pressure was applied to the cooled roll.

These bakers suggested additional dough development by hand kneading or by a dough brake (sobadora). Laboratory testing supported this observation that oxidizing agents and surfactant dough improvers give maximum effectiveness in well-developed doughs. Later commercial trials showed that 5 to 8% of a non-wheat flour could be carried by the wheat flour with dough strengthening provided only by an oxidizing agent in well-developed doughs. When 10% or more non-wheat flour was present, quality was marginal unless a surfactant-type dough conditioner was used to supplement the oxidizing agent.

Comparison

Major differences in bread production and quality criteria in the two locations related to climate as well as altitude e.g., dry and cold in La Paz, hot and humid in Santa Cruz. La Paz bakers use higher dough absorptions (up to 75% in some locations) to counteract drying effect of atmosphere during mixing and baking. Some Santa Cruz bakers were observed using as little as

50% dough absorption. Baked rolls showed the influence of altitude. With essentially similar doughs into the oven, La Paz doughs expanded more, giving higher volumes especially when dough strengtheners were used. The Santa Cruz products, while of good volume, had a relatively more compact grain which they preferred in that region.

TABLE I. Preparation of Blends for Commercial Trials in May 1979

Blends of non-wheat flours and dough additives were prepared at DGNT laboratory for use in 1/2 quintal (23 Kg) of flour on the replacement basis. They were transported by the team to the bakery; used with the baker's wheat flour and other ingredients.

La Paz

(1)	10% rice, 20 ppm $KBrO_3$, 0.3% SSL	2.3 Kg. rice 69 g SSL .92 g Bromolux
(2)	5% soy, 30 ppm $KBrO_3$, 0.3% SSL	1.15 KG soy 69 g SSL 1.38 g Bromolux
(3)	5% soy, 10% rice, 20 ppm $KBrO_3$, 0.3% SSL	1.15 Kg soy plus blend (1) above.
(4)	5% soy, 5% quinoa, 30 ppm $KBrO_3$, 0.3% SSL	1.15 Kg quinoa plus blend (2) above

Santa Cruz

(1) and (2)	5% soy, 30 ppm $KBrO_3$, 0.3% SSL	1.15 Kg soy 69 g SSL 1.38 g Bomolux
(3)	5% soy, 5% rice, 30 ppm $KBrO_3$	1.15 Kg rice 1.38 g Bromolux 1.15 Kg soy, packed separately
(4)	5% soy, 5% rice, 30 ppm $KBrO_3$, 0.3% SSL	same as (3) with 69 g SSL blended with rice and Bromolux
(5)	10% rice, 20 ppm $KBrO_3$, 0.3% SSL	2.3 Kg rice 69 g SSL .92 Bromolux

Description of Ingredients

Rice Flour - 7.7% Protein 67°C BEPT	-	Milled from brokens in commercial wheat mill.
Soy Flour - 52.8% Protein 42 NSI	-	Toasted and milled in DGNT Laboratory from commercial flakes
Quinoa Flour 11.3% Protein	-	Variety Real, 1979 harvest washed, dried and and milled in DGNT Laboratory
$KBrO_3$ - Bromolux containing 50% $KBrO_3$		From Pennwalt Co. in U.S.A.

SSL - Emplex from C. J. Patterson Co. in U.S.A.

Wheat Flours -

La Paz A	11.4% Protein	0.57% Ash
C	11.7% Protein	0.72% Ash
Santa Cruz D	14.5% Protein	0.79% Ash

TABLE II. La Paz Trials

La Paz - May 23-24, 1979

The bakery was a very large room with two kerosene-fired brick hearth ovens built into one long wall; one SIAM-UTIL mixer (2 quintales capacity); two wooden dough troughs; work tables; proof boards; bun pans, pan racks. Room temperature - 58-63°F (14-17°C). Relative humidity - 27-47%. Water supply was outside and was heated to 90°F over an outside fireplace.

Blends tested:

(1) 10% rice, 20 ppm $KBrO_3$, 0.3% SSL
(2) 5% soy, 30 ppm $KBrO_3$, 0.3% SSL
(3) 5% soy, 10% rice, 20 ppm $KBrO_3$, 0.3% SSL
(4) 5% soy, 5% quinoa, 30 ppm $KBrO_3$, 0.3% SSL

Formula (as used in DGNT laboratory).

Composite Flour	100%
Sugar	4%
Salt	1.5%
Yeast (compressed)	2%
Water, estimated	65-67%

Procedure

Mix: 40-45 minutes in SIAM-UTIL.

Ferment: 2 to 2 1/2 hours (after mixing completed) in wooden troughs, doughs covered with cotton cloths.
Dough temp, approx. 75°F; room temp. 58-63°F.

Scale and Mold: By hand onto cloth-covered wooden slabs - about 30 minutes.
Scaling weight 80-150-280 g pieces formed into marraquetas and pan france.

Proof: 30-60 minutes on wooden slabs stacked on each other; thus low air circulation minimized drying of surfaces.

Bake: Proofed dough pieces transferred to bun pans, bottom side up, tops slashed, and baked about 30 minutes.
Oven temp. 1st day 200°C
2nd day 275°C

Results: All breads rose well in proof and in the oven. They were well accepted by the owner and the baker who helped. No off-flavors were detected. The breads containing soy flour had rich, brown crusts that the baker compared favorably to fat-containing breads.

The breads were distributed throughout the office of DGNT for testing at home. No negative comments were received. Significant comments from two Indian maids (employed in U.S. personnel households) suggested preference for these breads over those they buy in the stores.

TABLE III. Santa Cruz Trials

Santa Cruz - May 29-30, 1979

The bakery was one large room with two wood-fired metallic hearth ovens, one at each end. The wood-burning occurred in a separate chamber adjacent to the oven. A chamber along the other side of the oven served as a proofing area. The main room held one long dough trough, work tables, a SIAM-UTIL mixer, sobadora, bun divider, dough molder for marraquetas, balance, wooden proof boards. Water supply was outside and water heated outside. Room temperature approx. 74°F (23.5°C) -room relative humidity approx. 46%.

Blends tested:
(1) 5% soy, 30 ppm $KBrO_3$, 0.3% SSL.
(2) same as one - reduced sugar -
(3) 5% soy, 5% rice, 30 ppm $KBrO_3$.
(4) same as (3) plus 0.3% SSL.
(5) 10% rice, 20 ppm $KBrO_3$, 0.3% SSL.

Formula: First bake - DGNT formula.
Additional bakes - Santa Cruz bakers formula (reduced sugar and water)

	DGNT	S.C. Bakers
Sugar	4%	.87
Yeast	.52	.52
Salt	1.5	1.5
Water, estimated	65-67%	63-65%

Flour: 1st day - NEVADA - Compania Molinera, Rio Grande, Ltd.
2nd - PRINCESA SIMSA - No analytical data available.

Procedure

Mix: 25-35 minutes in SIAM-UTIL.
Ferment: 2-4 hours in wooden trough uncovered. Punch down after 2 hours.
Scale: 3000 g to bun divider, 30 pieces/100 g.
Mold: Dough molder for shaping marraquetas.
Proof: 35-40 minutes at 30°C on wooden slabs with cloth dividers.
Bake: Transfer 12 dough pieces to long peel, bottom side up, cut, and place directly on hearth. Oven holds yield of 1/2 quintal.

Oven Temp: 1st day 175-195°C
2nd day 210-220°C

Note: No water was added to oven, but a significant amount accumulated during the first bake, creating a steam atmosphere. This resulted in more even, rich brown color in subsequent bakes.

Results:

Those batches containing SSL all rose higher in the oven than the bakers 100% wheat flour control. Without SSL (bromate only) the volume was good, only slightly lower than control. The breaks were not as bold as control or SSL blends. However, they were acceptable and considered saleable. The bakers suggested additional development might be needed with bromate, commenting they use a sobadora for sweet doughs (pan dulce) which often contain bromate. The question remains whether they would want to expend the additional labor on the marraquetas, a price controlled item. Up to 12 local Santa Cruz bakers participated in these baking trials, showing interest in the composite flours and helping in all phases of the bread-making process. They approved the results and noted no off-flavors in the breads.

B. Final Commercial Bakery Trials, November 1980.

In September 1980, composite flours for bakery and pasta trials were produced in a demonstration at the La Inglesa Mill (see Section L of Main Report). Several sacks of the appropriate blends for baking were shipped to the three demonstration cities as follows:

BLEND	LA PAZ	SANTA CRUZ	COCHABAMBA
8% Quinoa	X		
5% Soy	X	X	X
5% Soy/5% Corn	X	X	X

The principal objective of these trials was to demonstrate the functionality of composite flours for producing marraquetas in mechanized and in artisan bakeries. The three locations chosen represented three different altitudes and climates and a range of baking conditions. All were large cities which had active bakers' associations. The demonstrations served to introduce the composite flour concept and its technology to the several local bakers who attended the demonstrations each day. Their presence and interest provided a keen interchange of ideas with DGNT and WRRC scientists.

Prior to bakery trials, the blends were analysed for ascorbic acid and test-baked at the DGNT laboratory. Proximate analyses were determined at WRRC.

BLEND	MOISTURE %	PROTEIN[a] % (AS IS BASIS)	ASH % (AS IS BASIS)	ASCORBIC ACID PPM	BREAD
100% wheat flour	11.95	11.20	0.60	0	Excellent
5% soy	11.36	14.91[b]	1.07[b]	100	Excellent
5% soy/5% corn	11.33	13.44	1.05	119	Fair
8% quinoa	11.33	12.22	0.71	20	Poor

a. Nitrogen X 6.25 for composites; N X 5.7 for 100% wheat flour.
b. These values would indicate that soy flour addition was between 5.7 and 6.0%.

The ascorbic acid (AA) determination indicated the required 100 ppm was present in the soy and the corn/soy blends but only 20 ppm was in the quinoa blend. Upon inquiry we learned that the quinoa blend was the first produced and before the ascorbic acid feeder was operating properly. Baking tests in the laboratory confirmed the AA deficiency and its correction with 80 to 100 ppm added to the flour at dough mixing time. Laboratory baking results were excellent for the 5% soy blend, but only fair for the 5% corn/5% soy blend which was significantly improved with 0.2% SSL. To provide for its inclusion in tests, packets of 46 g of SSL, sufficient for 1/2 quintal batches were prepared for

adding at the mixer in the bakery trials. Since the quinoa blend was demonstrated only in La Paz, the necessary ascorbic acid addition was blended with a portion of the composite flour in the laboratory, then mixed with the remainder of the test sample in the bakery.

To provide continuity in the daily production of composite flour breads, a baker from an artisan shop in La Paz was hired to accompany the team members in all three cities. He was responsible for organizing the ingredients, dough make-up, oven scheduling and baking. On the first day in each city, the team conducted preliminary baking tests without the local bakers present to acquaint themselves with and to determine optimum baking conditions in each situation. The major adjustment was water. In general, the La Paz baker, accustomed to a dry climate, tended to use more absorption water than the bakers in tropical Santa Cruz. Absorption was decreased after initial trials. The blends varied in absorption as follows:

5% soy	53 to 70% water
5% corn/5% soy	65 to 76%
8% quinoa	60 to 66%

In the tests, the formulas of the local bakers were adopted. The following are the ranges used for each ingredient in each location. These percentages are estimated, since no precise measurements were possible with the flour and water.

	La Paz	Santa Cruz	Cochabamba
Flour Blend	5 to 25 Kg	5 to 23 Kg	23 Kg
Yeast	0.5 to 2% Fresh Compressed	0.22 to 0.5% Active Dry	0.65 to 1.1% Active Dry
Sugar	2.0%	2 to 2.2%	0.6 to 6.5%
Salt	0.5 to 1.6%	1.0 to 1.6%	1.1 to 1.5%
Water	60 to 76%	60 to 76%	53 to 70%

As mentioned earlier, all blends contained 100 ppm ascorbic acid. The dough conditioner, SSL, was added at the bakery to some of the 5% corn/5% soy blends.

With few exceptions, the baking results were excellent. The marraquetas were equal to the locally produced rolls in respect to dough handling characteristics, bread volume and general appearance. The internal color was always darker with soy and corn and slightly lighter with the quinoa. The main exception to good quality was the 5% corn/5% soy blend when it was baked without SSL. This blend not only had a 10% dilution of the wheat flour with the non-wheat flours, but also carried 5 to 6% more water due to the extra absorption demanded by the pregelatinized corn flour. Trials with SSL indicated that the 0.2% level was sufficient to overcome most of the problems.

From the flavor standpoint, all breads were acceptable. Bakers could detect quinoa but did not object. They could not detect soy or corn flavors. Some noted preferences for more or less sugar or salt, but no off-flavors were noted.

Between 15 to 30 local bakers attended each demonstration. Always included was the president of the local Bakers' Association in the demonstration city. The National President of the Bolivian Bakers' Association, Sr. Severo Lucana, traveled with the team to each city. At each bakery, he introduced the team and explained the demonstration process. A DGNT scientist then explained the project and the details of the day's work.

La Paz Trials

The first of the final trials were held in a fully mechanized bakery at the Fleischmann's Baking School located in Industrias Venado, S.A., the yeast company in La Paz (12,000 feet elevation). Trials followed in two artisan shops, one in La Paz and the other in the altiplano suburbs at 13,000 feet elevation. The locations and blends tested were:

	Mechanized	Artisan 1	Artisan 2
8% quinoa, 92% wheat	X	X	X
5% soy, 95% wheat	X	X	
5% corn, 5% soy, 90% wheat			X

Mechanized Bakery: The 8% quinoa blend (25 Kg) was mixed 40 minutes in the Siam Util, fermented 2 hours, then 10 Kg portions of dough were passed 30 to 40 times through a dough brake to provide well developed doughs. After a 30 minute rest, doughs were mechanically divided and made up into marraquetas, then proofed and baked on the hearth with steam added. The baked product had good volume and color.

The 5% soy blend was mixed in a Hobart-type mixer equipped with a dough hook. The dough, based on 5 kg of flour, was fermented 2 hours, developed on the dough brake (20 passes), rested and finished as described above. The breads had good volume and crust color.

The visiting bakers could detect the quinoa odor and flavor but did not object. Quinoa is a familiar food in this locality. They could not detect the soy flour in the 5% soy blend, commenting it was similar to their 100% wheat flour bread. It should be noted that this lot of soy flour was darker than lots previously used and might have contributed noticeable color to the product. However, at this point in time the bakers were receiving very high extraction flour from the mills, thus were becoming accustomed to off-white crumb, which was not unduly changed by the soy.

Artisan Bakery: Two artisan bakeries served for demonstrations in the La Paz area. In one trial, dough kneading of a portion of the dough supplemented hand mixing of the original ingredients.

A. In the first bakery within the city of La Paz (12,000 ft elevation), 25 Kg batches of two different blends were tested. They were 8% quinoa and 5% soy blends. both contained 100 ppm ascorbic acid but no other dough conditioner was added. Salt and sugar were dissolved in the dough water in a well made in the flour. Fresh yeast was crumbled with some of the flour and added with the remaining flour during 10 minutes of hand mixing. The total dough mass was well blended but no kneading occurred. Both doughs received about 3 hours fermentation, a short rest period, hand scaling and molding of marraquetas, a short proof time and baked on a hearth of a kerosene-fired oven. Lack of dough development was reflected in results which gave rough crust appearance, some irregular shapes and cuts. Otherwise, volumes were similar to the baker's 100% wheat breads.

B. In the second artisan bakery located in the altiplano suburbs at 13,000 feet elevation, the 8% quinoa blend was repeated along with a 5% corn/5% soy blend. Both contained ascorbic acid. A 0.2% level of SSL was added to the corn/soy blend at dough mixing. Both blends were hand mixed as described above for bakery A, then fermented about 2 1/2 hours, scaled, molded, proofed and baked on a kerosene-fired hearth oven. Before scaling, one portion of the corn/soy blend dough was hand-kneaded 10 minutes to add dough development. This blend contained SSL and gave reasonably good volumes which were markedly improved with the 10 minutes of hand-kneading. The quinoa blend also gave reasonably good volumes which were similar in appearance to the bakers standard wheat product.

This was the first commercial test with a blend containing the pregelatinized corn flour. Dough absorption determined by the baker was 6 to 12% higher than for the 5% soy or 8% quinoa blends, thus creating an additional demand on the carrying capacity of the wheat flour. These doughs were softer and later trials without SSL showed the need for the surfactant type dough conditioner. While the corn/soy bread volumes and appearance were acceptable to these bakers, they expressed concern with the heavy scaling weight of dough necessary to compensate for the water loss during baking and cooling. Generally, the bakers in La Paz and other high altitude cities add considerably more water during dough mixing to counteract the high evaporation losses occurring at every stage of the process. One baker estimated that a marraqueta scaled to provide 75 g baked bread would lose approximately 20 g water in the oven, 5 grams during cooling and 8 grams during selling. The legal minimum baked weight for this price controlled bread does not have a moisture requirement.

Santa Cruz Trials

The artisan and the mechanized bakeries were both located within the city of Santa Cruz at 1350 feet elevation. The 5% soy and the 5% corn/5% soy blends were tested. DGNT scientists made the decision to test these blends without SSL or any other surfactant additive. During the previous year, the Santa Cruz bakers had seen successful demonstrations of the effectiveness of these additives. On the first day in preliminary trials, using artisan methods and 5 Kg batches, the corn/soy blend was tested with and without SSL. A few visiting bakers did note the effectiveness of the SSL.

Active dry yeast is used in Santa Cruz because it is beyond the La Paz distribution area for fresh compressed yeast. It is started in a portion of the water, with some sugar and/or flour added, for about 15 minutes before mixing with the other ingredients.

Mechanized Bakery: An open bowl artofex type mixer (PENSOTTI) was used for both doughs. Some development occurred which was supplemented by a dough brake after 2 1/4 hours fermentation. After a short rest, doughs were scaled on a bun divider, machine molded and baked on a metal hearth oven.

The 5% soy blend was judged by the bakers to have acceptable volume and color with bold breaks, whereas the corn/soy blend gave less than standard volume for this shop and less bold breaks.

Artisan Bakery: Hand mixing in troughs was based on 12 Kg (1 arroba) of flour. Active dry yeast was added to water with some of the flour to prove 15 minutes before mixing into the doughs, which were well blended, but not developed, fermented 2 to 2 1/2 hours, scaled and molded manually to 80 and 100 g pieces, proofed, and baked in a kerosene, direct-fired hearth oven.

The 5% soy blend had good volume but the 5% corn/5% soy blend gave less volume than typical of this shop with 100% wheat flours. This result reflected the lack of dough improvement and absense of SSL, the surfactant dough improver. Color and flavor were quite acceptable to the bakers.

In both of these trials in Santa Cruz the lack of a suitable dough conditioner was reflected in the poorer baked volumes and cut appearance in the breads made from the 5% corn/5% soy blend. This blend not only carried 10% non-wheat flours but also approximately 5% additional absorption beyond that needed for the wheat and soy, due to the pregelatinized corn flour. Bakers are reluctant to mix doughs stiffer than the consistency they use. However, this consistency varies considerably among bakers, especially those in artisan shops.

As in La Paz, the higher dough absorption with the pregelatinized corn flour in the blend was of concern because it created heavier crumb in the breads. Evaporation losses during cooling and selling were not a problem in this humid climate.

Cochabamba Trials

Only one bakery was used in Cochabamba. It was located in the city at an altitude of about 8000 feet and was a mechanized shop. On the first day, all the equipment was used to achieve maximum dough development. On the second day, doughs were mechanically mixed with subsequent processing by hand to simulate an artisan shop. The 5% soy and the 5% corn/5% soy blends were both tested each day. The corn/soy blend was baked with and without SSL, providing an excellent opportunity to demonostrate the need for and effectiveness of this type of dough conditioner to a group of bakers who had not been previously introduced to the composite flour concept.

Mechanized Procedure: All doughs (23 Kg flour basis) were mixed in a large open bowl, German mixer having an arm that was stationary during blending of

ingredients, then moved up and down, folding the rotating dough onto itself. Some develoment occurred which was supplemented by a dough brake after 2 to 2-1/2 hours fermentation. Doughs were hand scaled and molded, proofed and baked in a metal hearth oven, directly on the hearth and also on trays.

The best volume, color and boldness of break was obtained with the 5% corn/ 5% soy blend containing SSL. Bakers were impressed with the contrast for the same blend baked without SSL. The 5% soy blend (without SSL) had good volume equal to this shop's standard wheat bread. However, the surface breaks were lacking boldness, possibly due to an extremely low absorption (53%) compared to 65% used the second day with more success.

Artisan Procedure: The dough brake was eliminated to minimize development, otherwise the procedure was as decribed above. Absorption was about 65% for the 5% soy blend and 70% for the corn/soy blend which also contained SSL based on the previous day's success. Both products were excellent. Bakers were impressed with overall results, with bread volumes, color and general appearance of the marraquetas with the dough conditioners.

These Cochabamba bakers main concern, which reflected that of all the Bolivian bakers, related to a constant supply of good quality flour with the proper levels of non-wheat flours and dough improvers. Because they are closer to the customers complaints, they feel they inherit the millers problems and must correct for any lack of quality control on the millers part.

SUMMARY

At this point, the Bolivian bakers appear ready to accept composite flours and new dough improvers such as ascorbic acid and SSL. They already have access to AA. Small samples of SSL, left from the baking tests, were given to those interested in further trials in their own bakeries.

Successful marketing practices for SSL and other surfactant dough improvers should include a distribution center in La Paz rather than in the tropical cities. Research at WRRC has shown deterioration of functional properties in some surfactants when stored at high temperatures and high humidity. Part of this is due to chemical breakdown, and part to caking of the lipid-like substance, so it is not easily dispersible.

Bolivian bakers' chief concern seems to be with the wheat flour quality and the high extraction level currently being milled. While they fear further dilution of already weak flours with non-wheat flours, the demonstrations showed that dough improvers can overcome these problems. Some now see the Composite Flour Project as the channel by which the government can control the quality of the flour being milled.

In December 1979, the Bolivian government raised the legal maximum extraction rate of flour from 72% to 76%, which resulted in a significantly darker flour, and more important to the baker, a weaker flour. From chemical analysis of flours and observations on color of flour and bread crumbs, it appears some mills might be producing up to 80% extraction flours. These have a higher nutritional content in terms of increased vitamins from the bran and germ. However, for the baker they represent poor quality flours with dark crumb characteristics.

Successful implementation of this project will depend on strong quality control measures to insure good baking flours. In addition, soy flour color must be improved to provide a lighter product.

INFORMATION PACKET

AGENDA FOR INTERAGENCY COMPOSITE FLOUR POLICY COMMITTEE MEETINGS[1]

Meeting I (April 28)

I. Orientation

A. Purpose (objectives) of composite flour program (see Attachment 1).

B. Tasks accomplished to date (see Attachment 2).

C. Tasks remaining (see Attachment 3).

D. Role of Interagency Policy Committee: Provide guidance; set assignments; establish timing; review Sub-committee work; make decisions.

II. Implementation Plan for Composite Flour Program

A. Criteria for developing the implementation plan.

1. Optimum nutritional impact with minimum change and variation in product character.
2. Low cost.
3. Import substitution.
4. Ease of regulation.
5. Etc.

B. Elements of the Implementation Plan and Actions Required (see Attachment 4).

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[1] In cooperation with USAID/Bolivia and DGNT identify government agencies and trade associations, etc., that should be represented on this committee.

Meeting II (May 1)

III. Identify Agencies Responsible for Actions and Appoint Working Sub-committees.

A. Identify agency or agencies responsible for specific implementation actions outlined under II (above).

B. Appoint the following sub-committees to develop proposed plans and procedures for various actions and carry out other tasks as specified (see Attachment 5).

1. Decree Sub-committee.
2. Flour Manufacturing Sub-committee.
3. Regulatory Sub-committee.
4. Agricultural Supply Sub-committee.
5. Pricing and Disbursement Sub-committee.
6. Consumer Education Sub-committee.
7. Flour Users Training Sub-committee.
8. Finance Acquisition Sub-committee.
9. Nutrition Sub-committee.

C. Establish time schedule for completion of specific tasks outlined in Attachment 5.

Meeting III (May 7)

IV. Reports from Individual Sub-committees.

A. Suggested modification in tasks and dates of completion.

B. Proposed plans of attack on problems by sub-committees.

C. Policy committee discussion.

D. Plans for next meeting. When, subjects, etc.

Appendix B-19

OBJECTIVES OF COMPOSITE FLOUR PROGRAM

I. Improve the nutritional quality of the Bolivian Diet.

A. Increase the protein content of wheat foods by 20% and improve protein quality by fortifying all 225,000 MT of wheat flour currently produced in Bolivia with 5% food-grade defatted soy flour produced with soybeans grown and processed in Bolivia.

B. Increase the vitamin-mineral content of wheat foods by enrichment of all wheat flour. In particular, iron enrichment is desired.

II. Provide Foreign Exchange Savings.

A. Substitute domestic soy, corn, rice, and quinoa for imported wheat by partial replacement of wheat flour with soy, corn, rice and quinoa flours in production of bread, pasta and biscuits. In all products, the level of soy substitution is 5%. For bread there would also be 5% substitution with either corn, rice or quinoa flour. For pasta, there would be up to 25% substitution with corn flour.

B. Substitute vegetable oil extracted from domestic soybeans for imported crude soy and cottonseed oils. This becomes possible by creating improved markets for the soybean meal by-product of soy oil production.

III. Stimulate Domestic Agriculture and Agribusiness and thus increase employment in the agricultural sector.

A. Increase production of domestic soybeans, corn, rice and quinoa by providing a stable increased market for these commodities.

B. Create 11,250 MT of food-grade defatted soy flour production capacity at SAO, Santa Cruz and thus improve the utilization of already installed soybean oil extraction capacity.

C. Improve the utilization of corn flour production capacity (20,000 MT per year) already existing at PAM in Mairana.

D. Create rice flour and quinoa flour production capacity when these flours can be economically utilized.

TASKS ACCOMPLISHED * COMPOSITE FLOUR PROGRAM

I. Secured technical and financial assistance from USAID in the amount of $ US 296,000 for the period February 1977 - June 1980 for composite flour research and development and feasibility determination.

II. Prepared estimates of nutritional impact in Bolivia if all wheat flour were fortified with 5% soy flour and specified vitamins and minerals.

III. Installed and operated research bakery and cereal processing laboratory.

IV. Feasibility, engineering and cost studies were completed for creating about 10,000 MT of food-grade defatted soy flour production capacity at SAO, Santa Cruz.

V. Demonstrated pilot scale production of food-grade defatted soy flour using Bolivian soybeans partially processed at SAO and finished processed at DGNT.

VI. Carried out laboratory research on composite flour formulation and utilization that predict good technical feasibility for composite flours in Bolivia.

VII. Demonstrated experimental production of composite flour breads at several commercial bakeries.

VIII. Demonstrated acceptability of composite flour breads at September 1979 Santa Cruz Agricultural Fair.

IX. Held a highly successful 3-day composite flour seminar August 1979 attended by over 100 bakers, millers, soy processors, corn processors, representatives from various government agencies, personnel from USAID Bolivia, and other interested parties.

X. Demonstrated the physiological acceptance of
   5% soy fortified marraquettas
   5% soy - 5% quinoa fortified marraquettas
in a 28-day feeding study at Ciudad del Nino involving 45 children. The study was supervised by a medical doctor.

XI. Demonstrated good acceptability of
   5% soy fortified marraquettas
   5% soy - 5% quinoa fortified marraquettas
   5% soy - 5% corn fortified marraquettas
   5% soy - 5% rice fortified marraquettas
in a consumer acceptance test involving over 2,000 persons in all parts of the country. The test was carried out by a Bolivian consulting group (CBPI) under contract with DGNT.

XII. Purchased necessary feeders and equipment (currently in transit to Bolivia) to refit a flour mill (La Inglesa at El Alto) to provide a 15 MT per day commercial capacity to produce composite flours including enrichment with vitamins and minerals.

TASKS REMAINING

I. Decide critical issues to facilitate planning.

   A. Compulsory or voluntary composite flour program?

   B. Will the bread improver potassium bromate be allowed?

   C. Timing. Will the program of composite flours commence at an early date with corn flour that is already available or await availability of the food-grade defatted soy flour?

II. Installation and demonstration of the composite flour mill, La Inglesa.

III. Develop flour mill modification plan and estimate costs.

IV. Establish vitamin-mineral enrichment level, sources of supply and cost.

V. Develop plans to make rice and/or quinoa flours available for the program.

VI. Develop ingredient and product specifications.

VII. Develop regulatory methods and procedures and organization to carry out.

VIII. Develop plan for adequate supply of agricultural commodities.

IX. Develop ordering, pricing and accounting procedures for ingredients and composite flour.

X. Develop plan for technical assistance and training for bakers and pasta manufacturers.

XI. Develop financial plan.

XII. Develop plan for informing the public about the composite flour program.

XIII. Prepare Decree and plan for implementation of composite flours.

Attachment 4

Appendix B-19

DRAFT:WRRC

FORMAT

of

IMPLEMENTATION PLAN

for

IMPROVING THE NUTRITIONAL QUALITY OF WHEAT FOODS IN BOLIVIA

PROPOSED DECREE	FLOW DIAGRAM for PRODUCT, BILLING, AND PAYMENT	TIME SCHEDULE of EVENTS	PROPOSED COSTS and BUDGET (Abbreviated)

ACTIONS PLANS

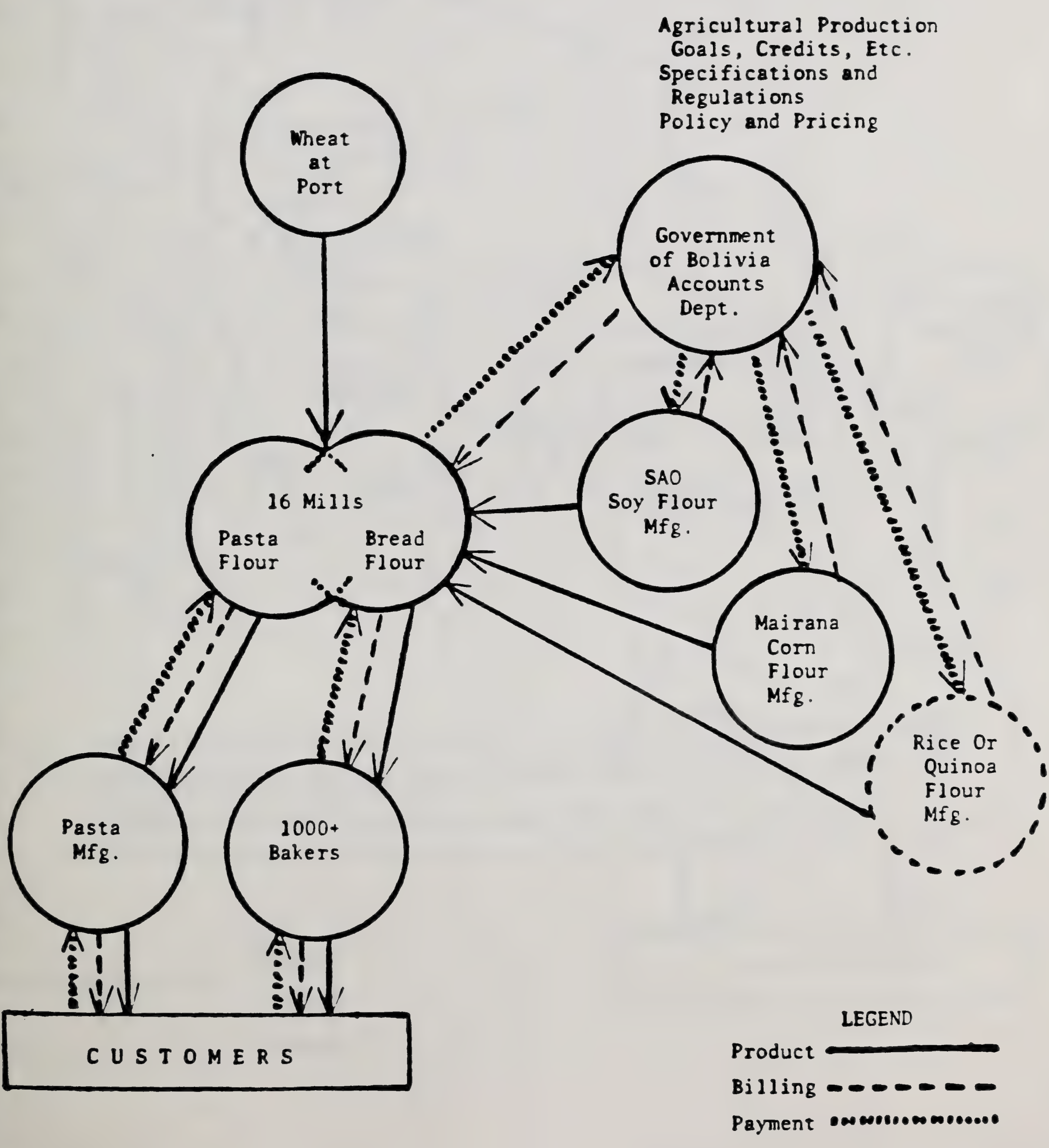
I. Government of Bolivia
   a. Policy
   b. Specifications
   c. Pricing
   d. Regulatory
   e. Commodity Supply
II. Millers
III. Soy Processors
IV. Corn Processors
V. Bakers
VI. Other

SUPPORTING DOCUMENTS

I. Market Acceptance
II. Physiological Acceptance
III. Feasibility of Soy Flour Production and Cost Estimates
IV. Demonstration Composite Flour Mills; La Inglesa.
V. Bread: Baking Research Commercial Experience
VI. Nutritional Impact Estimates
VII. Feasibility of Corn Flour Production and Cost Estimates
VIII. Methodologies for Specifications and Regulations
IX. Other

IMPROVING THE NUTRITIONAL QUALITY OF WHEAT FOODS IN BOLIVIA

Flow Diagram for Products, Billing, and Payment

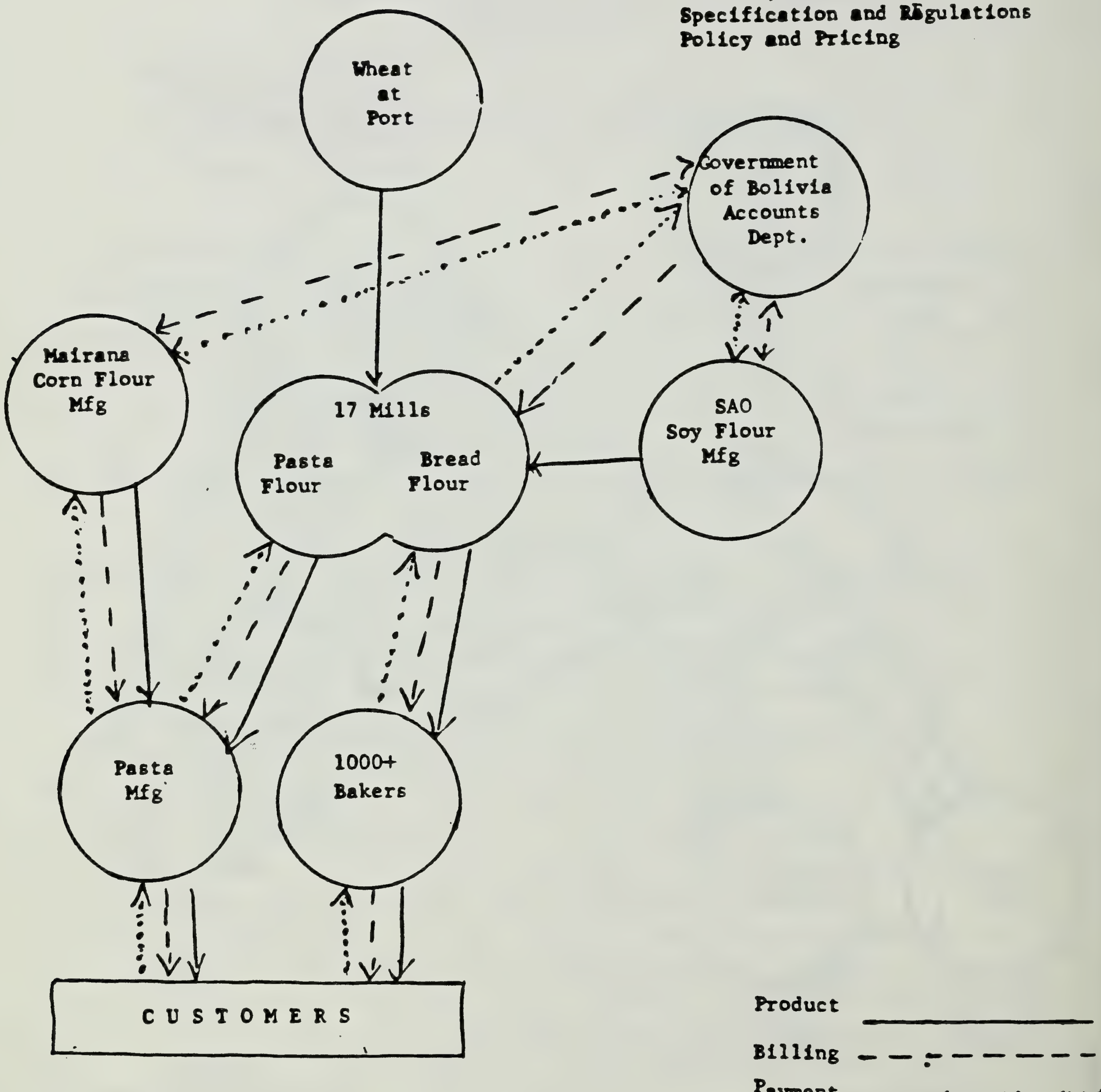


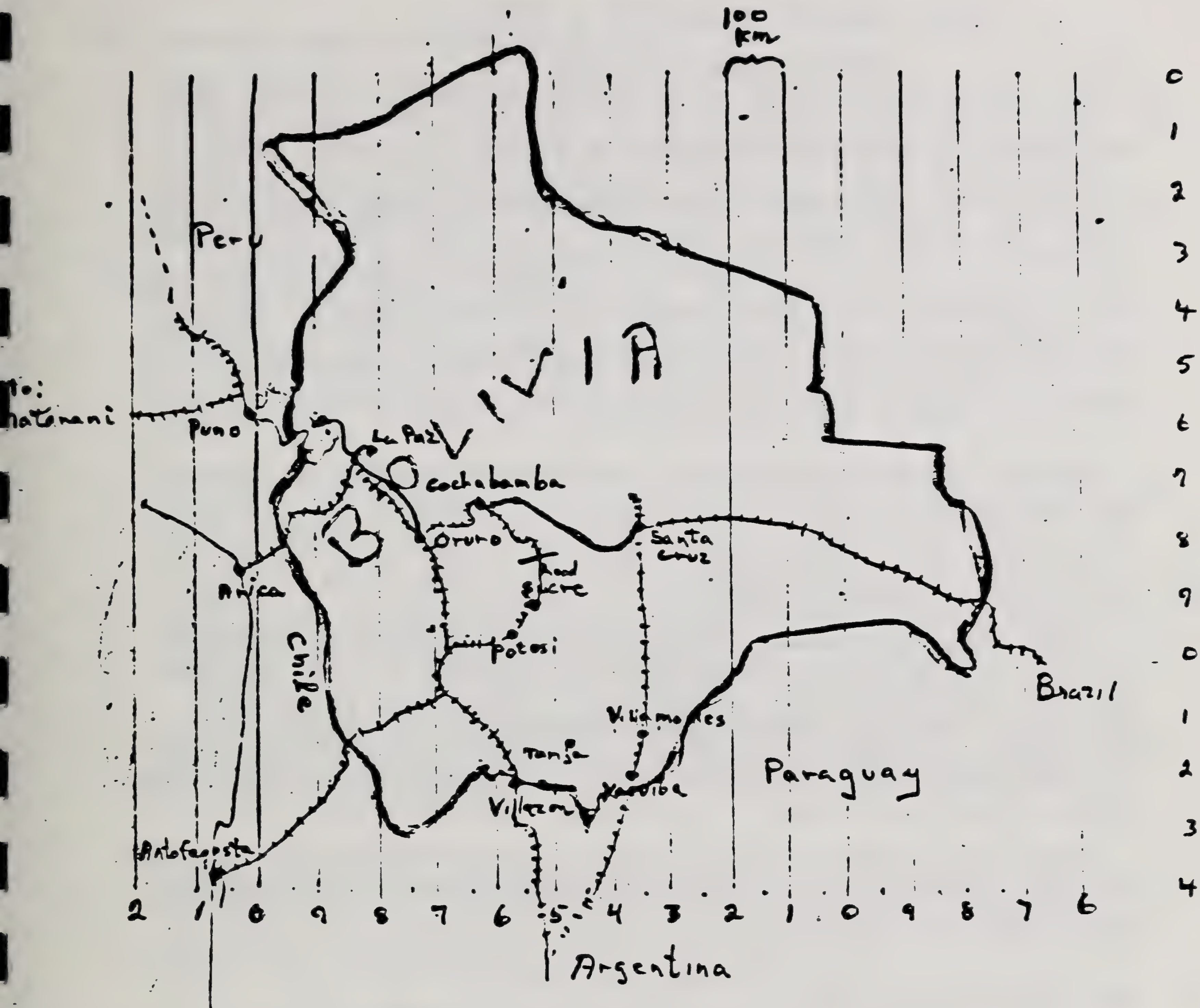
Attachment 4
Revised May 5, 1980

IMPROVING THE NUTRITIONAL QUALITY OF WHEAT FOODS IN BOLIVIA

Alternate Flow Diagram for Products, Billing and payment

Agricultural Production
Goals, Credits, etc.
Specification and Regulations
Policy and Pricing





- Many rice mills around Santa Cruz; more than 40 rice mills in Country.
- Wheat mills at; La Paz, Oruro, Potosi, Sucre, Cochabamba, Tarija, and Santa Cruz (14 mills in all)
- Quinoa production concentrated around Oruro and the altip' no.
- Oilseed solvent extraction mills at Santa Cruz and Villamo..te

ACTIONS REQUIRED TO IMPLEMENT A COMPOSITE FLOUR PROGRAM IN BOLIVIA

I. Decree Requiring Manufacture of Composite Flours

A. (GOB) Prepare a decree making it compulsory for wheat flour millers to add--by a certain date--a minimum of 5 percent soy flour and 5 percent of either corn, rice, or quinoa flour (depending on location and/or availability) to all wheat flour. The amount and type of dough conditioner and vitamin-mineral fortification also shall be specified. For pastas, addition of soy flour will be 5% and corn flour up to 25%. Quantities of non-wheat flours delivered to each flour mill are to be based on the quantity of imported wheat distributed to each wheat flour mill (see item VI). Finalize decree after receiving public comment.

B. (Wheat Flour Millers and Others) Provide GOB with comments for modifying decree.

II. Modification of Wheat Flour Mills

A. (GOB) Provide information and technical assistance to wheat flour mills for the installation of equipment for blending soy flour and other non-wheat flour (corn, rice, or quinoa) with wheat flour at all wheat flour mills. Also provide information and technical assistance for installation of a feeder for bromate, or other dough conditioner, and/or iron enrichment at all flour mills. (Flour for pasta manufacture will not contain a dough conditioner.)

B. (Wheat Flour Millers) Arrange for purchase and installation of flour blending equipment with possible financial assistance or loan guarantees by the GOB (see item VII).

III. Specifications for Flours

A. (GOB) Develop specifications and packaging requirements for flours made from soybeans, corn, rice, and quinoa to be used in the composite flour program and for the wheat flour and the composite flour itself. Provide suggested manufacturing practices to manufacturers for achieving these specifications.

B. (Manufacturers of Soy and Other Non-wheat Flours) Become familiar with government specifications for flours to be used in the composite flour program and develop quality assurance procedures to achieve these specifications.

IV. Inspection and Enforcement of Decree

(GOB) Develop an inspection procedure for assuring the carrying out of the composite flour program and for assuring that specifications are achieved. Develop a procedure for receiving and acting on complaints regarding flour and flour product quality at all levels of the trade. Establish and identify a governmental unit and personnel positions to achieve these objectives.

V. Pricing of Flours to be Used in the Program

A. (GOB) Develop a procedure for establishing and periodically modifying the prices to be paid by the government to the manufacturers of soy and other non-wheat flours to be used in the composite flour program and the prices to be paid to the government by the millers for these non-wheat flours.

Establish or identify a governmental unit and personnel positions to accomplish this objective. In establishing both the initial prices and the subsequent periodic price changes, account needs to be taken of the amortization of equipment, the costs of transportation and other costs, as well as the desired quantities of non-wheat flours, the commodity supply and price situations from which the non-wheat flours are made, and the nutrition and foreign exchange benefits of the composite flour program.

An important goal of pricing should be to assure an adequate supply of non-wheat flours from domestic crop production. However, there should be provision for allowing imports of raw product (e.g., soybeans) when domestic crop production is inadequate.

B. (Non-wheat Flour Manufacturers) Establish or identify an organization or personnel for providing cost and other information as required to the GOB for assisting in the setting of prices for the non-wheat flours to be used in the composite flour program and for generally representing the interests of the non-wheat flour manufacturers.

C. (Wheat Flour Millers) Establish or identify an organization or personnel for representing the interests of millers in the pricing of soy and other non-wheat flours to be used in the composite flour program and the composite flour blends.

VI. Quantity of Soy and Other Non-wheat Flours to be Supplied and Billing Procedures

A. (GOB) Utilizing data on receipts of imported wheat by each wheat flour mill, develop and publish the quantity of soy and other non-wheat flours to be shipped to each mill monthly, or some other appropriate time period. In consultation with the industry, develop and specify procedures to be used by the soy and other non-wheat manufacturers for billing the government and by the government for billing the wheat flour mills for these flours. Also develop and specify procedures for the wheat flour

millers to make payment to the government and for the government to make payment to the soy and other non-wheat flour manufacturers. Establish or identify a governmental unit and personnel positions for achieving this objective.

B. (Non-wheat Flour Manufacturers and Millers) Become familiar with quantity requirements and billing procedures for soy and other non-wheat flours to be used in the composite flour program. Suggest modifications for improvements and establish procedures for complying with the requirements.

VII. Consumer Education Program

(GOB) Plan and carry out a nationwide program informing people of the composite flour program and its nutritional and economic benefits to Bolivia. Establish or identify a governmental unit for overseeing this program but work through other agencies, e.g., advertising firms, extension service, home economists, etc., to accomplish this objective.

VIII. Training Flour Users to Use Composite Flours

(GOB) Develop and carry out a program to inform and train bakers, pasta manufacturers, and others in the proper techniques for achieving good performance when using composite flours. Establish or identify a government unit to work with bakers! associations and individual bakers to achieve this objective.

IX. Financial Arrangements

A. (GOB) Arrange for obtaining loans from AID, Interamerican Development Bank, etc., as necessary, to assist in providing credits to wheat flour mills and to manufacturers of soy and other non-wheat flours for modification of their facilities and for providing credits to finance a 2-month inventory of required flours for initiating the composite flour program for the consumer education and flour user training programs, and for establishing the pricing and regulatory units within the government.

B. (Non-wheat Flour Manufacturers and Millers) Specify needs (if any) to the government for financing the modifications required for manufacturing or blending soy and other non-wheat flours, for building an inventory of flour, etc.

X. Contracting for Soy and Other Non-wheat Flour

A. (GOB) Contract with SAO for the production, packaging, and delivery of 2-month's supply of soy flour for each wheat flour mill at prices established by the pricing unit. Contract with Mairana for the required supply of corn flour for the wheat flour mills in Cochabamba. Contract

with a potential manufacturer of rice flour for the required supply of rice flour for the wheat flour mills in Santa Cruz. Contract with a potential manufacturer of quinoa flour for the required supply of quinoa flour for the wheat flour mills on the Altiplano. If rice and quinoa flour are not available at prices established by the pricing unit, contract for the required corn flour at all the wheat flour mills to meet the objectives of the program.

B. (Soy and Other Non-wheat Flour Manufacturers) Become familiar with the quantity requirements of the wheat flour mills for soy and other non-wheat flours. Survey transport system to determine most favorable mode to each mill. Make arrangements for providing soy and other non-wheat flours to each wheat flour mill.

INTERAGENCY COMPOSITE FLOUR POLICY COMMITTEE (OUTLINE OF TASKS)

I. Specify flour extenders, fortificants, vitamins, and minerals, and their levels, to be included in the composite flour program based on nutritional, supply, and economic considerations. Demonstrate technical feasibility by establishing a commercial composite flour mill, operating it, and testing the composite flours in various bakeries and pasta plants. Initially, it will be assumed that the composite flour program includes 5% soy flour and 5% corn flour in all wheat flour. This assumption can be modified by the Policy Committee.

II. Establish a policy for pricing non-wheat flours to be used in the program. Prices should cover costs and provide non-wheat flour manufacturers as well as wheat millers adequate margins.

III. Indicate the means for assuring a regular adequate supply of commodities specified for use in the composite flour program. Consider need for agricultural extension and credit programs, price supports, imports, etc. Assume July 1982 startup of a National Composite Flour Program.

IV. Determine the additional cost or savings to the Government of substituting non-wheat flours for wheat flour and indicate the probable benefits to the economy.

V. Specify quality standards and means for assuring quality.including personnel and financial requirements for achieving this.

VI. Specify the mechanics of carrying out the composite flour program including personnel and financial requirements.

VII. Prepare a final plan and decree for the composite flour program taking into account legal aspects and financing needs and sources.

VIII. Subject the plan and decree to review by millers, bakers, non-flour manufacturers, other GOB agencies, USAID/Bolivia. Revise as necessary.(Written comments followed by individual meetings, eg., with the millers.)

IX. Present the proposed plan and decree to the Economic Policy Commission for approval (Ministers of MINPLAN, MICT, MACA, FINANCE).

SUBCOMMITTEES

Parts of the above tasks can be accomplished through the appointment by the policy committee of individuals or ad-hoc working subcommittees. Tasks II, III, and IV, for example, could be assigned to a Pricing Subcommittee. Task V could be assigned to a Quality Standards Subcommittee with the following specific Tasks:

A. Develop specifications (standards) for non-wheat flours and for the composite flour itself. Include dough conditioners to be allowed, and their levels, to achieve good acceptability of final products.

B. Specify the type of packaging to be used for non-wheat flour to retain quality and condition and to provide for ease of handling at the flour mills.

C. Develop inspection procedures for assuring compliance with the composite flour program.

D. Develop a system for registering and acting on complaints from users (may be part of C).

E. Develop a program for providing necessary information to bakers, pasta manufacturers, etc. to achieve good results

in the production of their products.

F. Estimate personnel and financial requirements for carrying out the above program elements.

Task VI could be assigned to a Program Implementation Subcommittee with the following tasks:

A. Identify potential manufacturers of non-wheat flours and their technical and financial needs for producing a supply of flours that would meet specifications established for these flours.

B. Establish equipment needs for the flour mills for blending composite flours; prepare means for acquiring, installing, and servicing equipment, etc.

C. Establish means of determining periodic quantities of non-wheat flours required by each flour mill taking into account inventory requirements, delivery schedules of carriers, etc.

D. Establish procedures for billing flour millers and for paying the producers of the non-wheat flours used in the program. Specify how this will be integrated with the present system used by the government for billing and collecting for wheat deliveries to the flour mills.

E. Estimate personnel and financial requirements for carrying out the above program elements.

Criteria for Selection of Members of the Policy Committee

Members of the Policy Committee should be selected on the basis of the following criteria:

1. The number of members should be kept as small as possible; probably not more than 7 to 10.
2. Not all agencies need to be represented on the Policy Committee, but it is essential to have representation from MICT, MACA, MINPLAN, and Ministry of Finance. Other ministries can be represented on the various subcommittees.
3. There should also be representation from USAID, the flour millers, and at least one person representing the interests of growers of the commodities and manufacturers of the non-wheat flours.
4. The policy committee members should be at or near the policy making level, but perhaps more importantly, they should be selected for their ability to make useful contributions to the committee and willing to contribute time to do so.

/4-25-80
REnochian:mgm

Appendix C-1

POTENTIAL FOR PROTEIN FORTIFICATION OF WHEAT FOODS IN MOROCCO

Report of Assessment Trip to Morocco
May 4-15, 1977

Project: Improving Nutritive Value of Wheat Foods

Conducted under WRRC/AID PASA Agreement #931-11-560-231-73-3168048

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ACKNOWLEDGEMENTS

Thanks are extended to WRRC co-workers, D.A. Fellers, Project Leader for the WRRC/AID PASA Agreement, M.M. Bean, and A.D. Shepherd, for valuable input and advice in the development of this report, and to Patricia Sue Gibson, USAID, Morocco, for her enthusiastic support during the assessment.

* * * * *

GLOSSARY OF ACRONYMS

AID (USAID)	Agency for International Development
CEPEN	Cellule de Planification et d'Etudes Nutritionnelles (Planning and Nutritional Studies Cell)
CIAN	Interministerial Commission on Food and Nutrition
CRS	Catholic Relief Service
EN	Entr'Aide Nationale (Social Welfare)
GOM	Government of Morocco
INAV	Institut National Agronomie et Veterinaire (National Veterinary and Agronomy Institute)
MOPH	Ministry of Public Health
NFDM	Non-fat dried milk
ONICL	L'Office National Interprofessionel des Cereales et Legumes (National Interprofessional Office of Cereals and Vegetables)
PLAN	Secretary of State for Planning and Regional Development
RTI	Research Triangle Institute
SEPO	Societe d'Exploitation des Produits Oleagineux
WRRC	Western Regional Research Center

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Appendix C-1

SUMMARY STATEMENTS

1. Morocco, with a population of nearly 18,000,000, consumes a diet consisting mainly of wheat and barley. Annual per capita wheat utilization in 1976 was 194 kg., comprising domestic soft wheat, 29 kg., domestic durum wheat, 92 kg., and imported soft wheat, 73 kg. Of this wheat, approximately one-half is used as food through autoconsumptive means, whereas the remainder is converted into foods via commercial channels. In the urban areas, not less than 90 percent of consumed wheat foods are purchased at commercial outlets; in the rural areas, this figure is about 45. All imported soft (bread) wheat is milled in 65 large mills in Morocco. Data were collected on the 1976 allocation of wheat, the amount of flour sold by these mills on a province basis, and the number of mills in each province. The majority of wheat is consumed as yeast-leavened bread. If bread is to be fortified with protein, the most logical point of fortification would be at a large mill in a province selected on the bases of quantity of flour available from this mill, and the nutritional need. A project is proposed whereby this concept would be implemented as a demonstration of wheat fortification to the GOM.
2. Potential protein sources for fortification include green peas, lentils, chickpeas, fava beans and soybeans. Excluding the latter, these commodities are domestically grown. However, the general state of technology, at least initially, predicates the use of soy flour.
3. Barley and corn, both of which are produced in sufficient quantities to satisfy present demand, are lower in price than imported wheat and could possibly be used for composite flour programs to reduce costs of protein fortification and to reduce wheat imports.

4. The one-half to four year old child is the most nutritionally vulnerable group in Morocco, and has been defined by the GOM as the primary target for nutritional improvement. Pregnant and lactating women, and school children are given second and third priority, respectively.
5. On the basis of 1970-1971 data, the diets of those living in Bidonvilles, those with monthly expenditure levels of no more than 466 DH, and those in the Southern Economic Region were the most deficient in calories and protein.
6. According to 1972 data, moderate and severe protein calorie malnutrition ($\lesseqgtr$ 80 percent of norm) among those less than 4 years of age was most prevalent among the rural population. Within the urban sector, of those $\lesseqgtr$ 20 months of age, those residing in Bidonvilles and Old Medinas were the most malnourished; the incidence in some instances being equivalent to that of rural children.
7. Moderate and severe protein calorie malnutrition was observed in 24-56 percent of the children among the provinces and prefectures studied.
8. Within vitamin/mineral status, the average Moroccan diet was most deficient in riboflavin (vitamin B_2) followed by calcium, and vitamin C. In addition, vitamin A and niacin were deficient in the diets of the rural and urban population, respectively. Those residing in Bidonvilles were the only group who were deficient in all nutrients studied.
9. The Government of Morocco is actively involved in nutrition planning with an Interministerial Commission on Food and Nutrition (CIAN) and Cellule de Planification et d'Etudes Nutrionnelles (CEPEN) charged with defining and coordinating nutritional problems and research as well as developing a national nutrition strategy. USAID/Morocco and Research Triangle Institute (North Carolina) are cooperating with CEPEN in the development of such a strategy.

10. The Government of Morocco has many active programs which result in a nutritional impact for the participants. Many Ministries and Secretaries of State have such programs including Public Health, Social Welfare, Education, Youth and Sports, and Interior.

I. INTRODUCTION

Population

Morocco, a country of 172,415 square miles (slightly larger than California), had an estimated total population of 17,964,724 in 1976, of which 62 percent lived in rural areas. The 1975 population distribution by province and by urbanization is given in Table 1.[1/]

Countrywide, the population is growing at a rate of about 3.0 percent per year, but owing to a rural to urban migration, cities are growing at least twice as fast.

General Economic Situation[2/]

Morocco suffers from a chronic unfavorable trade balance and large annual budget deficits because of large subsidies on foods. The operating budget for the Ministry of Finance, most of which goes for subsidies, was DH 245 million in 1973.[3/] Following a "crisis" in 1974, government policy was to keep consumer prices low; therefore, the budget increased to DH 3.5 billion in 1975. In 1977, because of removal of subsidies on a number of products, it had been reduced to DH 1.2 billion. Subsidies still remain on wheat, sugar, fats and oils, and tea.

Major foreign exchange earners for Morocco are phosphates, citrus fruits, early vegetables, tourism, and remittances from Moroccans employed abroad. Major imports are food, mostly wheat, and petroleum.

Although there have been some increases in the value of agricultural exports in recent years, the foreign debt situation has worsened. The near

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1/ All tables and figures are at the end of report.
2/ This section based on discussions with USAID and U.S. Embassy officials.
3/ One DH = U.S. $0.223.

term prospects for phosphate exports are uncertain, which together with a projected 1977 drought is expected to worsen the foreign debt situation.

Total GNP in 1975 was DH 31.8 billion which was equal to DH 1,839 per capita. The projected growth rate for the economy during the period of the 5-year plan ending in 1977 was 7.5 percent per year. Actual growth during this period averaged only 6.0 percent. Business investments fell sharply in 1973 with some increases since then. Currently, however, there is some caution by new investors because of the rapid growth in population and the projected drought.

The government is currently developing a new 5-year plan (1978-1982). Although the plan is expected to contain elements of economic development, it will stress social equity more than in the past. The plan also is expected to emphasize decentralization of government to permit local groups greater participation in decision-making regarding local problems. The plan will contain a section on nutrition improvement; a unit is being developed in the GOM with assistance from USAID, to study nutrition needs, and recommend and evaluate nutrition programs.

The Agricultural Situation

Since a large part of the unfavorable foreign trade balance is due to imports of food, there is a focus by the Government of Morocco on trying to increase production and exports of agricultural products. Since most agricultural land is already under cultivation, any increases in production must be brought about by productivity increases which have traditionally lagged far behind productivity in other sectors.

During the period 1963-1975, GNP, based on 1960 prices, increased at an average annual rate of 4.9 percent or a total of 59 percent for the 12-year period. During the same period, agricultural productivity increased an average

of only 1.6 percent per year. Furthermore, within the agricultural sector, there have been great inequities in the rate of growth of productivity during the 1963-1975 period. It has been estimated that the modern or commercial agriculture sector utilizes about 15 percent of the arable land and produces 85 percent of the commercial production. This sector uses commercial inputs of seed, fertilizers, pesticides, and equipment. It also has a well-developed market system for both domestic and export markets, gets first priority on available credit, and has increased its productivity rapidly. The traditional or subsistence sector of agriculture, on the other hand, has declined in its total productivity in the same period (Mid-American International Agricultural Consortium, Jan. 1977).

In a country which is dominated by agriculture, both in terms of its major source of production and employment, and in which the population is growing at a rate of 3.0 percent per year, an annual growth rate of only 1.6 percent in agricultural production results in serious problems. Foremost among these problems are increased imports of food and a growing unfavorable trade balance, declining real income per farm family, and increased rural unemployment and underemployment. The GOM with some assistance from USAID is working on several projects, the objectives of which are to increase agricultural productivity.

Of the total land surface in Morocco, about 18.5 million hectares or 37 percent of the total are in agriculture and forests. Of this land, about 7.3 million hectares are arable, 6 million are non-arable grazing lands and 5.2 million hectares are forests. About 53 percent of the arable lands are used in equal proportions for barley and wheat, with durum wheat accounting for about three-fourths of the area in wheat, and soft wheat (this is the wheat used to make bread) accounting for the other fourth. Other cereal crops

(corn, oats, etc.) occupy 9.3 percent of the arable land. Another 10.5 percent of the arable land is in pulses, vegetables, and annual non-food crops, mostly cotton and tobacco. Fava beans, chickpeas, green peas, and lentils make up most of the pulse production. Each year, about 22.5 percent of the arable land is in fallow. The volunteer weed and cereal growth on this land is generally used for pasture. The remaining 4.7 percent of the arable land is in fruit and olive production.

Wheat and barley are termed controlled cereals and the government has a major role in their pricing. All soft wheat must move through the National Cereals Office (ONICL) controlled marketing channels at a fixed price. In the case of durum wheat and barley, the government maintains a support price. For all three grains, the price will vary depending upon deviation from the standard quality. In addition, in the case of durum wheat and barley, the market price will go above the support when there are shortages.

Although most domestically produced soft wheat (about 25 percent of all domestic wheat production) enters commercial channels, estimates indicate that more than 75 percent of the total cereal production in Morocco, including barley, is utilized by autoconsumption, i.e., is either utilized directly on the farm on which it is grown, taken to a local miller for processing and returned to the farm in the form of flour, or traded in the local market (souk) for direct use without government supervision. In the so-called drylands areas where cereal grains are produced mostly by small farmers, nearly all of the grain produced is consumed directly by the grower and his family or sold in the souks in small quantities for direct use at home.

In spite of the large proportion of land devoted to cereal crops, because of the traditional high per capita cereal consumption, Morocco has

large annual deficits in its cereal requirements and must rely heavily on imports which have been mostly soft wheats used for bread. The wheat situation is discussed further in the section on wheat and wheat foods.

One class of agricultural commodity that is grown in quantities sufficient to satisfy local demand and to have an exportable surplus is pulses. Principal pulses exported are fava beans, chickpeas, and lentils, all of which might be used in a wheat flour fortification program. The potential for this use of pulses is discussed in the section on protein sources.

II. NUTRITIONAL STATUS

General

Life expectancy in Morocco is 53 years. During the past decade, general mortality has decreased from 18 to 16/1,000 population. Average infant mortality estimates vary with the year and the source of information. CEPEN estimates were 104 and 120/1,000 live births for urban and rural areas, respectively (1973). Weissmen (1977) reported a countrywide average of 130/1,000 live births for 1973 with values of 100 and 170 for urban and rural populations.

Efforts are being made to curb the rate of population growth. There is an active population control program, one-half of which is in the private sector.

Although the average per capita consumption of calories and protein seems adequate, variations in distribution and availability within the family, by expenditure levels, and among socioeconomic regions have resulted in several nutritionally vulnerable groups. In general, children from one-half to 4 years of age, comprising 16.0 percent of the total population, are seen as the primary target group by the Ministry of Public Health (MOPH), Entr'Aide Nationale (GOM Social Welfare Agency), Catholic Relief Services (CRS), and USAID/Morocco. Pregnant and lactating women and school children are given second and third priority, respectively. Targets, in terms of socioeconomic levels, are the urban and rural poor, those living in Bidonvilles, and those in the Southern Economic Region (RI), which includes Agadir, Tarfaya, Quarzazatl and Tiznit, (Figure 1). Other marginal groups include those residing in the new and old medinas, as well as artisans (Consumption and Household Expenditures in Morocco. 1970-1971).

Both location of residence and occupation (artisans) were used to denote socioeconomic status in the expenditures survey. Bidonvilles, literally "tin-can" villages, are areas where housing structures were made with minimum construction materials. The medinas are the old towns with high population density; the old medina being the oldest, or original, old town; the new (relatively) medina being the newer, old town.

Nutrient needs and deficits are discussed in terms of the recommended intake for the Moroccan population in 1970-1971. These are in general agreement with FAO recommended intake of nutrients (1974) for a population with the distribution patterns of Morocco.

Nutritional status is a function of many variables including sanitation, public health status, agricultural productivity, governmental policy, availability of food, income level and others. The nutritional status of Morocco will be described on the basis of available data. The results of various nutrition and household consumption surveys have been summarized (Nutrition Systems Study Unit - Morocco; Weissman, 1977). Those most relevant to this project will be referred to in this report.

Protein Calorie Malnutrition

Consumption Data

On the basis of the 1970-71 nationwide Consumption and Household Expenditures Survey, those with low expenditure levels, those living in Bidonvilles, and the Southern Economic Region showed the greatest deficits in calorie/protein intake (Table 2). Among these groups, cereals provided 66 to 77 percent of the dietary protein, with 11 to 21 percent being derived from animal sources. Data were based upon daily interviews with families for one week. Expenditures, quantities of foods purchased, as well as food produced

by the consumer were tabulated. The wide variation in daily consumption of protein (37 to 75g.) and calories (1337 to 2600) illustrates the importance of looking beyond national averages and identifying target groups.

An indication of the proportion of the population with lower expenditure levels may be gleaned from Table 3. Another indication is the percent of housing accounted for by Bidonvilles which is shown in Figures 2 and 3 on the basis of province and city. (In Figures 2 and 3, as well as succeeding figures, when no figures are given, this is due to lack of available data.) Kenitra, Rabat-Salé, and Tangier have the highest proportion of Bidonvilles. The diet of those living in Bidonvilles was deficient not only in calories and protein but in all nutrients studied. The intake of calcium and riboflavin was especially low (less than 40 percent of recommended intake).

Anthropometric Data

The most comprehensive anthropometric survey was conducted by the MOPH in 1971. The survey plan was based upon that used for the Consumption and Household Expenditures Survey. The only difference was that the MOPH only included those less than 4 years of age. Some 6,300 children, 0 to 4 years of age, in 15 urban and 13 rural locations were examined (MOPH 1973). First degree (90 to 81 percent of norm), second degree (80 to 61 percent of norm), and third degree (61 percent or less of norm) malnutrition were defined using the Ecole European Classification scheme. In most instances, irrespective of age, the degree of malnutrition in rural children was equal to or greater than that of various urban strata (Figure 4). Among urban children, less than 21 months of age, those residing in the Bidonvilles and old medinas appeared to be the most severely malnourished.

The prevalence of malnutrition throughout the first 33 months of life appears to be the result of numerous practices and circumstances. The majority

of Moroccans practice abrupt weaning onto a cereal-based diet. According to a recent CRS survey of 416 mothers, 93 percent followed abrupt weaning procedures. Of these 93 percent, more than two-thirds occurred between 7 and 23 months of age. The vulnerability of these young children to malnutrition appears to be a result of their intensive need for calories and protein for growth and maintenance, their susceptibility to parasites and infectious diseases, and their low priority within the family for receiving adequate food. The preponderantly cereal-based diet is not adequately meeting their caloric and protein needs.

Data on incidence of combined second and third degree (moderate and severe) malnutrition are plotted by province and urban sector in Figures 5 and 6. Although direct comparisons between provinces cannot be made, a relative indication of incidence may be gleaned.

Vitamin/Mineral Status

According to data from the Consumption and Household Expenditure Survey (1970-71), the most limiting nutrient in the average Moroccan diet appears to be vitamin B_2 (riboflavin). Calcium and vitamin C are also consumed in less than recommended levels (Table 4).

The relative intake of various vitamins and minerals by sub-groups within the population varies. For example, the diets of those living in Bidonvilles were deficient in all nutrients studied, whereas those living in the Southern Economic Region (RI) were deficient in vitamin C, calcium, vitamin B_2 and vitamin A in that order. Although the diets of the urban and rural populations were both most deficient in vitamin B_2, the relative order of the remaining deficient nutrients varied. Rural populations consumed less than adequate quantities of vitamin C, calcium and vitamin A, whereas urban populations consumed inadequate quantities of calcium and niacin.

Although vitamin D was not studied in the consumption survey, rickets has long been a nutritional problem in Morocco. The MOPH has had an active vitamin D supplementation program. For those not reached by this program, vitamin D deficiency may still be a significant problem.

Anemia, with the implicit deficiency in iron, has been referred to in several earlier nutrition surveys (Nutrition Systems Study Unit). The nature and extent of iron deficiency seems to vary. The consumption survey showed that those with lower incomes and/or residing in Bidonvilles were most likely to consume inadequate quantities of iron.

The importance of the B vitamins as components of coenzymes essential for the metabolism of macronutrients (carbohydrates, proteins, lipids), as well as the role of calcium and iron in bone and tissue structure, suggest that the Moroccan diet would benefit through enrichment with these nutrients.

III. GOVERNMENTAL NUTRITION POLICY AND PROGRAMS

The GOM has both a philosophical and a pragmatic interest in improving the nutritional status of the population. The King is interested in programs which improve the standard of living of the people. The current five-year plan includes among its goals a more equitable distribution of the fruits of expansion in a just social context. According to several sources, the new five-year plan, which is currently being drafted, includes social equity as a major goal.

Nutrition Policy and Planning

The Interministerial Commission on Food and Nutrition (CIAN) was initially conceived in 1959 to develop a national strategy for improving the nutritional status of Moroccans. The existence of CIAN was reconfirmed in 1972 by governmental decree. At that time, CIAN was charged with the responsibility of developing a national nutrition policy. Two specific activities were defined: a) To coordinate applied nutrition and nutrition education programs; and b) to coordinate research on nutritional needs and food behavior. CIAN includes representatives from the following:

Ministries

- Agriculture and Agrarian Reform
- Commerce and Industry
- Cultural Affairs
- Finance
- Information
- Interior
- Labor and Social Affairs
- Primary and Secondary Education
- Public Health

Secretaries of State

- Economic Affairs
- Entr'Aide Nationale and Handicrafts
- Planning and Regional Development
- Youth and Sports

Recently, the Secretary of State for Planning and Regional Development (PLAN) established a group responsible for nutritional studies and research within the Human Resources Division. This group, Cellule de Planification et d'Etudes Nutritionnelles (CEPEN) is charged with the planning, coordination and analysis of nutrition activities. The organizational structure is shown in Figure 7. CEPEN is expected to assist CIAN in its responsibilities as follows:

a) Define the nutritional problem(s) in Morocco;

b) in cooperation with appropriate ministries, develop a national nutrition strategy to be incorporated into the new five-year plan; and

c) coordinate nutrition activities.

AID/Morocco, through its contractor, Research Triangle Institute (RTI) (North Carolina), will assist CEPEN in developing the capability of nutritional planning and analysis. As a result of the three-year RTI contract, the following objectives have been defined:

a) The establishment of a self-sustaining capability within the GOM for nutrition planning and programming;

b) the development of a national nutrition strategy;

c) the articulation of nutrition policies and programs in the new five-year plan; and

d) the activation of various nutrition interventions by the end of the project (fall 1979).

Nutrition Programs

Several Ministries and Secretaries of State have active programs in social service which provide the participants with nutritional benefits. A brief summary of programs and intended impact is shown in Table 5.

The MOPH has conducted active programs in nutrition education and vitamin D supplementation through their mother-child health care (MCH) centers.

USAID/Morocco nutrition related activities consist of the contract with RTI to assist the GOM in planning a nutrition strategy, a loan held by CRS to administer and coordinate a Nutrition Training School in Marrakech (discussed later) and the administration of Title II commodities. CRS distributes Title II goods through the Social Ecucation Centers of Entr'Aide Nationale. The 39,000 MT distributed annually is one of the largest Title II programs in existence. Although the quantity of food and number of recipients, 575,000, have remained relatively constant for the past five years, the nature of recipients has changed. Title II commodities (CSM, soy fortified flour, oil, WSB or rolled oats) are no longer used in school lunch programs. Recent emphasis has been placed on preschool programs, with 375,000 of the recipients being preschoolers and their mothers. The remaining recipients are 25,000 orphans and 25,000 young girls (8-14 years) in handicraft centers and their families (175,000 total recipients). The World Food Program is participating in the school lunch programs.

Entr'Aide Nationale (EN) and CRS work in close cooperation with the programs of food distribution and nutrition education within the 250 Social Education Centers of EN. The location and numbers of centers are shown in Table 6. Each center has two monitresses in charge who receive nutrition training at the school in Marrakech. Typically, a center reaches 1,500 recipients or 500 families; the family consists of a mother and one preschool child who is brought to the center for height and weight measurements. A second preschool child, at home, is to receive an equal portion of the food. The mother comes to the center once a month and ordinarily receives 3 kg. soy fortified flour, 3 kg. CSM and 1-1/2 liters of oil. A nutrition-food

demonstration lesson is provided with each visit to the center. If available, soy fortified rolled oats or WSB is also distributed in 3 kg. quantities/family. The purpose of this program is to reach the poorest families in urban and rural areas. The location of the centers is, therefore, continually responsive to areas of greatest need, with new centers opening and others closing as a result.

The Nutrition Training School in Marrakech is coordinated by three nutritionists, a Moroccan, a Tunisian and an American. There are four Moroccans currently receiving nutrition training in Tunisia; they will be responsible for the school by 1978. The monitresses in charge of the Social Education Centers receive a one-month course on practical food demonstrations and nutritional information. These lessons are ultimately presented to recipients during their monthly visit to the center. Future plans include training in nutrition education as part of the curriculum at the handicraft centers. The Marrakech school would be responsible for initial training of the teachers in these centers.

The MOPH-GOM/UNICEF and Societe d'Exploitation des Produits Oleagineux (SEPO) have cooperated in a joint effort to produce Actamine-5, an infant weaning food comprised of locally available cereals and legumes, but containing a small percentage of imported non-fat dried milk (see Wheat and Wheat Foods Section). Actamine is available both commercially and through various governmental programs. Several agencies of the GOM Interministerial Commission are obligated to purchase various quantities of Actamine. In the case of EN, this is 400 MT per year.

IV. WHEAT AND WHEAT FOODS

Wheat Situation

The GOM has the major role in the purchase, distribution, export and import of cereals through an agency called L'Office National Interprofessionnel des Cereales et Legumes (ONICL). ONICL is administered by an interprofessional council comprising the Ministeries of Agriculture, Interior, Finance and Commerce, and representatives for cereal growers, cooperatives, millers, bakers and consumers. The fundamental objective of ONICL is to assure a constant cereals supply at stabilized prices to the Moroccan people. This is accomplished by regulating the commercialized sector of Morocco's cereals and legumes system. In the case of wheat, this involves credit to farmers; procurement of part of the domestic production, at a fixed price; responsibility for total imports; storage; distribution to 65 large commercial millers; payment of fees for milling and flour distribution; fixing flour prices; licensing of bakeries; and fixing bread and processed wheat food prices. Currently, fixed retail prices for flour and processed foods are below free market levels; i.e., GOM assures an affordable supply of wheat-based foods by subsidizing costs. Prices are fixed by Government decree.

The total supply and per capita utilization of major cereal grains are listed in Table 7, and the utilization trend of the same grains is listed in Table 8. Long-term trends of grain production and trade confirm that Morocco is farther from self-sufficiency in wheat now compared to 5 and 15 years ago. The area planted in cereals has increased by less than 8 percent since the early 50's even though total country requirements for the major cereals have increased from 2.9 million MT (average 1951-1955) to 5.2 million MT (average 1974-1975). Even though this discrepancy is partially ameliorated by somewhat higher yields of wheat and barley per acre at the present time, a large

proportion of the cereal requirement is being met by importation of soft wheat.

Exports and imports of the four major cereals from 1959 to 1975 are listed in Table 9. Soft wheat is becoming increasingly important in the national diet relative to durum wheat. Presumably as a result of urbanization and concomitant increases in per capita income, per capita consumption of soft wheat has increased from 28 kg. in 1959-60 to 87 kg. in 1974-75, and to (estimated) 102 kg. in 1976. This represents more than a three-fold increase in 15 years. Local production of soft wheat averaged 462,000 MT during 1971-75, and is projected to be about 500,000-600,000 MT during the next decade. The balance of soft wheat requirements has been met by increasing imports, and presumably imports will increase even further if the same demand for soft wheat continues to exist in the increasingly urban, and expanding, population. Between 1959-60 and 1974-75, imports of soft wheat increased from 45,000 MT to 1,040,000 MT, or 23-fold. The 1975-76 soft wheat imports were estimated to be 1,303,000 MT. This latter figure corresponds to a per capita consumption of imported soft wheat of 73 kg. Imports are mainly soft wheat from the European Economic Community and the United States.

The average per capita consumption of wheat (soft and durum) is estimated to be about 194 kg. for 1976. Since there exist predominantly wheat-eating and barley-eating regions in Morocco, regional per capita wheat consumption varies greatly.

Wheat Milling Industry

There are at least 600 wheat mills in Morocco, though most are local, small, artisan mills. Sixty-five mills, all members of the Professional Flour Millers Association, account for most of the soft wheat flour entering commercial channels; these mills account for the entire milling of imported soft

wheat. Negligible amounts of durum wheat are milled by these larger mills. Local soft wheat is purchased for milling, by ONICL, at a fixed price of 600 DH/MT (U.S. $134/MT). Imported wheat is purchased at world prices, c.i.f. Morocco. Approximately 90 percent of the imported wheat is milled at an extraction rate of 77 kg./100 liters of wheat, although this can go as high as 81-82 kg./100 liters for small-kerneled U.S. wheat. (The mean extraction rate by U.S. reference terms is 78 percent). This flour is termed farine nationale, and is sold by the millers for 855 DH/MT (U.S. $0.087/lb.). A farine deluxe accounts for the other 10 percent of soft wheat flour -- milled at 68 kg./100 liters, and sold at 864.3 DH/MT (U.S. $0.088/lb.) to patisseries. These prices are listed in Table 10.

The quantities of wheat milled, and resultant flour sold by the 65 large mills in 1976 are listed in Table 11. One can assume this is almost entirely soft wheat and virtually all imported (ONICL, Professional Flour Millers Association). The distribution of the majority of these mills, by province, is shown in Figure 8.

An attempt was made to ascertain the quantity of commercially milled soft wheat flour available in various provinces. Assuming that all of the flour produced by these commercial mills is sold within the province in which it is milled, the annual quantities of flour sold, or available, per capita in each of the respective provinces, are shown in Figure 9.

Provinces with three or less commercial mills are as follows:

Province	Number of mills
Tangier	3
Rabat-Salé, Kenitra, Tetouan	2
Agadir, Essaouira, Safi	1

Annual per capita sales of these mills within these provinces are as follows:

Province	Kg./capita/year
Tangier	121
Rabat-Salé	86
Agadir	44
Safi	38
Tetouan	35
Essaouira	23
Kenitra	14

A flow sheet depicting the commercial milling process of soft wheat in Morocco is available (AID Report No. 2, March 1970: Improving the Nutritive Value of Cereal Based Foods. Contract No. AID/csd-1586).

Flour Utilization

Slightly more than one-half of the total wheat flour (i.e., from soft plus durum wheats) consumed in Morocco is through autoconsumption, viz., wheat is milled into flour and converted into an edible food directly by the consumer (see Food Consumption Section below). The remainder of the flour is derived from commercial milling, and is sold as flour or is processed into bread, pasta, biscuits, cakes and couscous on a commercial basis. The number of commercial or modern bakeries, pasta and/or couscous plants, and biscuit plants in Morocco as of 1973 are listed in Table 12 on a province basis. The actual quantity of flour utilized by these industries in 1971-72 was approximately: Bakeries, 77,000 MT; pasta and couscous, 19,000 MT; and biscuits, 6,400 MT. These figures (ONICL, 1973) account for approximately 14 percent of available soft wheat flour, and approximately 5 percent of available soft wheat plus durum flour. The balance of the commercial flour is sold as flour to be converted by the homemaker into an edible form.

Appendix C-1

A simple formulation of flour, salt, yeast, water, and sometimes sourdought starter is typical for Moroccan breads. Both French-type baguettes and traditional round flat breads are available, although the availability of baguettes outside the largest urban centers is doubtful. The traditional loaf varies somewhat in shape and size but the most common is a dome-shaped loaf of relatively low specific volume. Loaves are about 20 centimeters in diameter, and weigh 300 grams at the commercial bakeries. More common, however, the dough is prepared, molded and divided in the home, and then taken daily to commercial bakeries to be baked. Composite loaves of wheat and barley flours reportedly are common in some provinces; the amount of barley approaches 100 percent in the predominantly barley growing region.

Wheat Foods Consumption

The quantities of cereals and cereal foods consumed per capita per year are listed in Table 13. The quantities of durum and soft wheats consumed per capita per year are listed in Table 14. The percentages of these wheat foods purchased via commercial channels are shown in parentheses.

Approximately 96 percent of durum, and 100 percent of soft wheat consumed within the urban population is derived from commercial production sources. In contrast, 41.7 percent and 91.6 percent of durum and soft wheat are utilized by autoconsumptive means in the rural sector. It can be calculated that wheat-based foods derived from commercial channels comprise not less than 90 percent of all cereal foods consumed, and more than 92 percent of all wheat-based foods consumed within the urban sector. In addition to the "purchased bread" listed, i.e., from commercial bakeries, it is fair to assume that the majority of the flour and semolina listed is converted into bread and pasta by the homemaker.

In contrast to the urban sector, rural consumption of commercially-derived wheat-based foods is not more than 28 percent of all cereal foods consumed.

It is emphasized that the data cited in Table 13 were gathered 7 years ago. The 1971 per capita consumption of soft wheat shown in Table 14, 71.06 kg. and 31.53 kg. for urban and rural sectors, respectively, had increased to 102 kg./capita/year countrywide average in 1976. It is likely that this huge increase in soft wheat consumption is concentrated within the urban areas which have experienced large population increases during the past six or seven years. Moreover, if the established patterns of wheat food distribution and consumption have been maintained, and there are no reasons to believe they have not, then consumption of soft wheat by the urban population will be derived virtually entirely from commercially processed wheat.

Annual per capita consumption of cereals and cereal products based on socioeconomic and income levels are documented for both urban and regional populations (1971).[4/] For different urban areas, Modernes Luxe, Modernes Moyens, Medina, Nouvelle Medina, Bidonvilles, and Semi Urbains and Douars Urbains, cereal and cereal production consumption showed a mean intake in 1971 of 141.67 kg./capita/year, with a range of 126.47 - 157.93 kg. On a regional basis (Region du Sud, Tensift, Centre, Nord-ouest, Centre-Nord, Centre-Sud, et de l'Oriental), the corresponding figures showed a range of 165.00 - 230.81 kg./capita/year, with a mean value of 193.32 kg. It is again emphasized that these data are at least 6 years old, and per capita cereal consumption has increased considerably since that time. Nevertheless, these trends in consumption probably still prevail. The higher cereals consumption on a regional basis compared to the urban populations reflects a higher cereals consumption among the rural population, which is also evident in Table 13. This is undoubtedly

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4/ Consumption and Household Expenditures in Morocco, IV. Food and Nutrition, 1970-71, Director of Statistics.

mainly autoconsumption and, in contrast to urban consumption, includes barley. These data together with those in Tables 13 and 14 reiterate the fact that all urbanites, irrespective of income level, appear to consume mostly wheat-based foods derived from commercial outlets.

Actamine-5

Actamine-5 is the trade name for a wheat-legume based weaning food introduced into Morocco in 1977 under a joint cooperative agreement between the MOPH, UNICEF and SEPO, a privately-owned commercial enterprise. SEPO provided the location and manpower, whereas UNICEF provided 70 percent of the equipment cost and formulation and instructive expertise. Though complete details were not obtained by the WRRC team, it appears that the current formulation of Actamine is as follows: Soft wheat flour, 23 percent; chickpea flour, 23 percent; lentil flour, 23 percent; NFDM, 15 percent, sucrose, 15 percent; vitamins and minerals, 1 percent. In 1975, the MOPH had sought a formulation consisting of 28 percent wheat flour, 38 percent chickpea flour, 19 percent lentil flour, 10 percent NFDM, 5 percent sugar, and vitamins and minerals.

The method of preparation appears to be as follows: Wheat flour is mixed with water containing α-amylase, then heated to 130°C under pressure; chickpea and lentil flours are added and the mixture is reheated to 130°C to ensure sterilization. At this point, the mixture is extruded, dried to 7 percent moisture "to stop amylase reaction" and then further dried to 3 percent moisture. The dried product is milled into a flour to which is added NFDM, sucrose, vitamins, minerals, and flavoring (banana during visit May 1977). SEPO claims the product contains 19.5 - 20 percent protein and has a 93 percent digestibility coefficient. SEPO stated that no change in formulation could be explored without approval by UNICEF (Dr. Aude, Tunisia).

Appendix C-1

During June 1977, Actamine was selling commercially for 2.40 - 2.60 DH/350g. package. This is equivalent to 69 to 75 U.S. cents/lb. SEPO claims the selling price is equal to the cost of production and that, therefore, they show no profit for this product.

Commercial samples of Actamine-5 were purchased by USAID/Morocco at 2.60 DH/350g., and were analyzed by WRRC upon return to U.S.A., with the following results:

% H_2O	% N	% fat	% fiber	% ash
5.22	2.97*	2.05	0.59	3.09

* Protein (N x 6.25) = 18.56%

PER = 2.08 (casein = 2.50)

Digestibility Coefficient = 95%

N Digestibility = 89% (corrected)

V. PROTEIN SOURCES

At present, Morocco does not have a local supply of protein products in a form suitable for fortifying wheat flour. Two classes of agricultural commodities are available, however, that are potentially usable for this purpose and which need to be evaluated. These are pulses and oilseeds.

Pulses

Principal pulses consumed in order of importance are fava beans, lentils, chickpeas, and dry peas. Annual consumption of all pulses averages about 11.2 kilograms per capita. Most consumption is in the Rharb, the south and the mountains; therefore, per capita consumption in these areas is greater than the national average.

Morocco is self-sufficient in pulse production and produces enough of the principal varieties for a sizeable export trade. Average annual production for the five-year period 1971-72 through 1975-76 and production for the 1975-76 season by variety, as well as quantities exported in 1975 are given in Table 15.

The average price received by producers in 1975 and the export price that year for fava beans, chickpeas, lentils, and green peas are given in Table 16. It would seem impractical to consider "other" varieties as they are either used for livestock feed or are produced in very small quantities.

The prices of chickpeas and lentils would appear to be too high for a straight substitution in soft wheat flour unless heavy government subsidies were involved. The export price of DH 1040 per MT for fava beans shown in Table 16 should be ignored because it is for seed beans. The producer prices of DH 660 and 610 per MT for fava beans and green peas, respectively, are competitive with soft wheat; therefore, processing costs to manufacture flours suitable for fortification, availability, government policy, and consumer acceptance are the factors that would need to be overcome to achieve this substitution.

Appendix C-1

Oilseeds

Although Morocco produces some oilseeds, and exports both olive oil and fish oil, on balance there are large annual deficits of fats and oils. These deficits are currently met by imports of both crude seed oils and oilseeds. The crude oils are refined in 14 refineries which have a total capacity of 186,000 MT per year. The imported oilseeds, along with Morocco's own production, are crushed in two modern oilseed crushing plants. One of the oilseed crushing plants is located in Casablanca (SEPO) with an annual capacity of 72,000 MT of seed and the other is located in Kenitra (SIGO) with an annual capacity of 120,000 MT. At present, both plants are underutilized, but government plans call for increased use of these plants, and for self-sufficiency in production of oilseeds and seed oils by 1982. The 1973-77 five-year plan called for 75 percent self-sufficiency by 1977 but fell short of this goal by a large margin.

Currently, the major oilseed crops in Morocco are sunflower, peanuts, and cottonseed. Peanuts are mostly eaten directly and probably will continue to be used for direct consumption because of price differentials between them and the other oilseeds. Major oilseed imports are soybeans and rapeseed. Future imports of rapeseed and rapeseed oil seem to be in some question because of health reasons (erucic acid content). Recent production and imports of the major oilseeds are given in Table 17.

In its attempt to stimulate production and to achieve self-sufficiency in oilseed and seed oil production, in December 1974 the GOM raised guaranteed prices on sunflower and cotton and announced guaranteed prices for soybeans, rapeseed, and safflower seed. Whether or not Moroccans are successful in their effort to become self-sufficient in oilseed production, it seems clear that the two oilseed crushing plants will continue to operate and will increase their

production by crushing greater quantities of imported oilseeds, if necessary. One or both of these plants would be the most likely source of a defatted oilseed flour that could be used to fortify wheat flour. Currently, these plants produce oilseed meal or cake that is a byproduct of their oil extraction operation. Part of this meal is used for livestock feeding within Morocco and part is exported. The annual production of meal by type for 1975 and 1976 and exports for 1975 are given in Table 18. In 1975, the price of the meals exported ranged from a low of DH 450 per MT for rapeseed to DH 621 per MT for sunflower. Soybean meal is not currently exported. Its local price as feed is, therefore, assumed to be within the range of the other oilseed meals.

Although a food-grade oilseed flour theoretically could be made from many oilseeds, only soy has achieved any significant commercial production on a worldwide basis and is, therefore, the only one given consideration here. To produce a food-grade full-fat or defatted soy flour in a Moroccan oilseed plant would require processing a high quality soybean, and possibly modification of present processes by installation of additional equipment. This would result in a flour price higher than for soybean meal. Plant processing costs for producing oil and meal for feed have been reported at about 25 U.S. cents per bushel of beans (approximately 41 DH/MT). Alteration of such a plant to permit production of edible defatted flour has been estimated to increase processing costs "only a few cents a bushel of beans" (or "a few DH/quintal").[5/] It can be assumed that similar cost differences would prevail in Morocco.

5/ Edible Soy Protein, Farmer Cooperative Service, U.S. Dept. Agr., FCS Research Report 33. Jan. 1976, p. 23.

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VI. CARBOHYDRATE SOURCES FOR COMPOSITE FLOUR

In view of the large annual foreign trade deficits experienced by Morocco, and the government's objectives of increased production of local food crops, consideration could be given to the use of low cost indigenous carbohydrate sources for extending commercial wheat flour, most of which is made from imported wheat. This could be done in conjunction with a protein fortificant, such as soy flour, to reduce overall fortification costs. Two commodities which might be feasible for this purpose are barley and corn.

Barley is the principal cereal crop grown in Morocco and in some regions is the major food crop eaten. Morocco produces most of its barley needs, though in some years small quantities are imported. The average annual production of barley for the five-year period between 1971-72 and 1975-76 was about 2.1 million metric tons. In 1975-76, production was about 2.9 million MT and in 1975 an additional 89,000 MT of barley were imported. Production, imports and utilization of barley can be gleaned from Tables 7, 8 and 9.

In the major barley producing areas, bread made only from barley flour is eaten in large quantities. In other areas, barley flour reportedly is blended with wheat flour in various proportions. Most of this blending is done by homemakers with little or no blending of barley and wheat flour by commercial millers and bakers.

Barley could be made available in the necessary quantities to blend with wheat in commercial flour mills through purchase of local supplies. A consideration in evaluating the feasibility of such a practice is the price of barley which is generally lower in price than wheat (Table 10).

Corn, like barley, is produced in Morocco in quantities nearly sufficient to satisfy domestic demand, with small quantities being imported (Table 9). A direct comparison of prices indicates that a substitution of

locally produced corn for some of the imported wheat could result in a cost savings (Table 10).

In addition to relative prices and availability of comestic supplies, further evaluation of barley and corn for producing composite flours should include probable nutritional impact, consumer acceptance and processing capability within Morocco.

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VII. PROJECT PROPOSAL AND RECOMMENDATIONS

Based on the data discussed in this report, and the parameters summarized in Table 19, the authors recommend two possible implementation projects.

1. Fortification of soft wheat flour, at the mill, in one or more provinces. The main fortificant initially would be defatted soy flour derived from the soy-cake residue remaining after oil extraction. This residue is currently sold domestically as a feed ingredient; preparation of food-grade soy flour would necessitate the use of high quality soybeans and process modification. Selected B-vitamins, iron and calcium also would be considered for enrichment.

Target provinces were selected on the bases of the limited number of large commercial wheat mills, a high per capita availability of commercial wheat flour, and nutritional need (Table 19). These parameters were selected to maximize the likelihood of having the fortified wheat flour reach vulnerable target groups in the urban area.

An outline of the tentative proposal follows:

Fortification of bread flour in one province with B-vitamins, calcium and 5 percent defatted soy flour. Based upon selection parameters, explore possibility with Rabat-Salé, Tangier, Agadir and Safi.

1977 - Fall

a. Determine GOM support/commitment to project. Elicit recommendations and responses from Ministries of Agriculture, Commerce/Industry and Public Health, Secretary of State for Economic Affairs, and PLAN (CEPEN, RTI, AID). Seek commitment of ONICL, Professional Flour Millers Association, oilseed processor(s), and miller(s) involved.

b. Presentation of proposal to multi-Ministerial Coordinating Committee, and carry through to GOM approval.

c. Consultant engineer to Morocco for assessment of potential for production of food-grade soy flour (concurrently to extent possible, establish potential for production of food-grade flours from indigenous pulses, legumes and oilseeds).

1978 - First Half

d. WRRC purchase imported defatted soy flour and vitamins/minerals, for experimental work and acceptance tests.

e. Test soy flour in breads with WRRC-INAV cooperation, as well as selected bakeries. Conduct preliminary consumer acceptance survey.

f. Install blending equipment in flour mill(s).

g. Define nutritional and consumption base of province in which project will be implemented.

h. Morocco to begin production of defatted soy flour.

1978 - Second Half

i. Flour mill(s) begin production of soy/vitamin/mineral fortified wheat flour.

1979 - Spring

j. Evaluate project: Nutritional and economic impact, effectiveness in reaching target.

Throughout project there would be feedback to GOM officials in decision-making positions through the multi-Ministerial Coordinating Committee for evaluation and possible introduction into other appropriate provinces.

2. Develop low-cost protein-rich wheat-based infant food, in cooperation with a Moroccan commercial agency. This product would have higher protein content and caloric density, and be lower in price than Actamine-5. The product would effectively and selectively reach target groups one-half to 4 years.

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Other Recommendations:

1. The dietary patterns of Morocco, in terms of cereal consumption, vary markedly by geographic regions. Any nutritional fortification program should be specifically designed for the province(s) in which it will be implemented on the basis of foods most commonly consumed. Any such project should be planned to reach the most nutritionally vulnerable.

2. Effort should be devoted to the most efficient means of reaching the one-half to four-year-old target group, i.e., through the food used for weaning. This would include traditional foods in the diet used for weaning as well as specially designed foods.

The availability of wheat and barley, as well as chickpeas, lentils, peas, soy and fava beans in Morocco would appear to provide good opportunities for simple blending operations whereby protein-rich foods could be produced. A cooker-extrusion operation, such as the Brady Crop Cooker, could prepare blends containing various proportions of these commodities. Such products would include weaning and infant foods, and would be produced easily and relatively inexpensively.

3. In future anthropometric surveys, it would be useful to gather data on height, as well as weight and age. Data could then be analyzed on the bases of height for age (stunting), weight for height (wasting), as well as weight for age (commonly used as an indication of PCM). This would be helpful to planners since chronic malnutrition commonly manifests itself in terms of stunting, whereas wasting is an indication of acute malnutrition.

4. Any future nutritional surveys should be designed to provide comparative data on nutritional status on the basis of socioeconomic regions and provinces. Planners would use such information to set valid priorities on the basis of nutritional need.

5. Special efforts should be made to improve the riboflavin and calcium levels of the diet. Various methods, including nutrition education, changing food habits and availability, and/or fortification of commonly consumed foods should be pursued.

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PEOPLE CONTACTED DURING ASSESSMENT TRIP TO MOROCCO

U.S. EMBASSY

Jerome Kuhl, Agricultural Attache
David Timmons, Economic Advisor

U.S. AID

Albert Disdier, Director
Frank W. Brecher, Assistant Director
P. Sue Gibson, Health and Nutrition Projects Officer
William H. Trayfors, Public Health Advisor
Dennis Wood, International Development Intern
J. Gerard Neptune, Food and Agricultural Officer
Neboysha R. Brashich, Program Officer
Larry Flynn, Food for Peace Officer
Abraham David, Research Triangle Institute
Michael V.E. Rulison, Research Triangle Institute
John Caddel, University of Minnesota

CRS

Conchita Sanborn

GOVERNMENT OF MOROCCO

Ministry of Economic Planning and Development

Mohamad Bijaad, Director
Ahmed Benrida, Division Chief, Human Resources
Khadija El Maadoudi

Ministry of Agriculture

Mohamad Rassifi, Chief, Economics Division
M. Guedira

Ministry of Public Health

A. Belhaj, Chief, Nutrition Service

Secretary of State for Social Welfare

Mohamed Lahlou, Secretary General and Director of Social Programs
Mme. Zineb Alaoui Bennani, Nutrition Coordinator

Secretary of State for Economic Affairs

Mohamad Benamou, Charge de Mission
Ahmed Alaoui Abdellaoui, Charge de Mission

Ministry of Commerce and Industry

M. Bennani

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National Institute of Agronomy and Veterinary Science

Barak Essatara, Professor, Human Nutrition

National Office of Cereals and Legumes

Mohamad Brick, Director
M. Jauhari

Moroccan Commercial Sector

M. Belmachi, Professional Association of Millers
M. Younes, Professional Association of Millers
M. Sirissy, Professional Association of Millers

M. Gruson, SEPO, (Oilseed Processors)

Baruk Flour Mill and Pasta Manufacturer, Salé

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Table 1

Population Distribution, 1975

Province or Prefecture	Urban	Rural	Total
Agadir	164,000	683,900	847,900
Al Noceima	33,000	240,000	273,000
Azilal	22,100	343,000	365,100
Beni-Mellal	142,400	347,300	489,700
Bouleman	11,200	118,600	129,800
Chaoven	30,700	247,900	278,600
El Jadida	121,600	534,300	655,900
El Kelaa-Sraghna	57,300	458,400	515,700
Essaouira	51,200	353,700	404,900
Fes	463,200	666,800	1,130,000
Figuig	24,900	73,700	98,600
Kenitra	320,100	723,400	1,043,500
Khemisset	67,000	320,600	387,600
Khenifra	71,000	204,100	275,100
Khovribga	173,200	198,800	372,000
Ksar-es-Souk	43,100	323,800	366,900
Marrakech	423,300	686,000	1,109,300
Meknes	386,700	300,300	687,000
Nador	63,300	468,000	531,300
Ouarzazate	46,000	535,400	581,400
Oujda	356,600	313,100	669,700
Safi	193,500	401,800	595,300
Settat	146,700	597,400	744,100
Tanger	240,900	89,800	330,700
Tarfaya	32,700	47,000	79,700
Taza	95,800	492,600	588,400
Tetouan	293,200	314,200	607,400
Tiznit	44,200	345,200	389,400
Pref. Casablanca	1,864,400	146,400	2,010,800
Pref. Rabat-Salé	635,700	110,100	745,800
Total	6,619,000	10,642,700	17,304,600

SOURCE: Le Maroc en Chiffres 1975, Secretariat d'Etat aupres du Premier Ministre Chargé du Plan et du Developpement Régional.

Table 2

Consumption of Calories and Protein

Nutrient	Moroccan average	Urban average	Rural average	Expenditure Level DH		Housing			Economic Region	Recommended intake 1/
				≤ 466	466-542	Bidonvilles	New Medina	Old Medina	RI South	
Calories (K cal)	2466	2202	2600	1337	2033	1809	2142	2162	1862	2207
Protein (g) total	71.0	62.7	75.0	37.1	56.6	51.2	59.6	61.9	56.2	60.0
Vegetable source (g)	58.7	45.9	64.9	33.0	49.1	40.4	45.1	47.4	45.3	
% of total	82.7	73.2	86.6	88.9	86.8	78.9	75.7	76.6	80.5	
Cereal source (g)	51.6	37.1	58.8	28.6	43.8	33.6	35.7	38.7	40.9	
% of total	72.7	59.2	78.4	77.1	77.4	65.6	59.9	62.5	72.8	

1/ Recommended intake used as standard by Morocco in 1970-71.

COMPILED FROM: Consumption and Household Expenditures in Morocco. IV. Food and Nutrition. 1970-71.

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Table 3

Distribution of Households by Socioeconomic Group and Average Monthly Expenditures, 1970-1971

Socioeconomic group	% of all households	Average monthly expenditures in dirhams
Technicians & professionals	3.93	873
Higher administrative officials	0.62	2,307
Office employees	1.44	1,079
Venders & small business men	9.21	564
Farmer-owners	35.40	383
Farm workers	11.27	250
Industry & mine workers	9.01	562
Transportation & service workers	13.34	509
Artisans & craftsmen	7.59	299
Other active population	3.18	271
Non-active population	5.01	375
Average-Morocco		448

SOURCE: Adapted from Consumption and Household Expenditures in Morocco. IV. Food and Nutrition. 1970-1971.

Table 4

Consumption of Vitamins and Minerals

Nutrient	Moroccan average	Urban average	Rural average	Expenditure Level DH		Housing			Economic Region	Recommended intake 1/
				$\lesssim$ 466	466-542	Bidonvilles	New Medina	Old Medina	RI South	
Calcium (mg)	296	295	298	153	247	196	279	275	285	500
Iron (mg)	14.3	11.4	15.9	8.1	12.3	9.3	10.8	11.6	13.2	10.8
Vitamin A (IU)	3281	4425	2696	1630	2323	3702	4301	3998	2945	3500
Thiamine (mg) Vitamin B_1	1.6	1.0	1.8	0.8	1.3	0.8	1.0	1.0	1.6	0.92
Riboflavin (mg) Vitamin B_2	0.5	0.4	0.6	0.2	0.4	0.2	0.4	0.3	0.7	1.30
Niacin (mg) Vitamin PP2/	15.6	10.6	18.1	8.8	13.9	8.1	9.7	9.9	17.1	15.2
Ascorbic Acid (mg) Vitamin C	50.6	76.2	38.2	20.9	34.5	52.2	71.3	71.7	31.5	72

1/ Recommended intake used as standard by Morocco in 1970-1971.
2/ Moroccan surveys denote niacin as Vitamin PP.

COMPILED FROM: Consumption and Household Expenditures in Morocco. IV. Food and Nutrition. 1970-71.

Table 5

Social Service Programs with Nutritional Benefits

Programs	Coverage	Type of nutritional impact
1. Entr'Aide Nationale		
Socio-education centers	125,000 families (250,000 children)	Immediate & long-term
Ouvreirs (vocational training)	25,000 families	Immediate & long-term
Orphanages	25,000 children	Immediate
Development projects - Food-for-Work	25,000 families	Immediate
2. Education		
Cantine scolaire	324,000 children	Immediate
Nutrition education classes (primary)	468,000 children	Long-term
School gardens	440 schools	Long-term
Animal husbandry projects	420 schools	Long-term
3. Promotion Nationale		
Work projects	100,000 families	Immediate
4. Ministry of Public Health		
PSE (MCH)	135,000 mothers & children	Immediate & long-term
Day Care Centers	3,000 children	Immediate & long-term
Family planning	75,000 families	Immediate & long-term
5. Youth and Sports		
Foyers Feminins (home economics)	24,000 girls	Long-term
Other programs	75,000 young adults	Long-term
6. Interior		
Foyers Feminins (home economics)	25,000 girls	Long-term

SOURCE: Nutrition Systems Study Unit - Morocco.

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Table 6

Social Education Centers - Entr'Aide Nationale

Location	Number of centers
Rabat	6
Casablanca	15
Agadir	9
Al Hoceima	6
El Jadida	7
Azilaj	3
Boulmane	4
Chaouen	5
Beni-Mellal	9
El Kelaa	5
Essaouida	4
Fes	13
Figuig	7
Kenitra	10
Khemisset	5
Khemifra	6
Khouribga	7
Errachidla	14
Marrakech	19
Meknes	11
Nador	6
Ouarzazate	13
Oujda	15
Safi	5
Tanger	12
Tarfaya	4
Tetouan	14
Tiznit	4

SOURCE: Catholic Relief Services - May 1977.

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Table 7

Total Supply and Per Capita Utilization of Major Cereal Grains, Select Years

Cereal grain	Average			
	1959-60	1969-70	1974-75	1975-76
Soft Wheat				
Production (000 tons) 1/	279	375	422	537
Imports (000 tons)	45	404	1,033	1,303
Domestic supply (000 tons)	324	779	1,462	1,840
Per capita (Kg)	28	52	87	102
Durum Wheat				
Production (000 tons)	732	1,321	1,292	1,597
Exports (000 tons)	102	1	-	48 2/
Domestic supply (000 tons)	630	1,320	1,292	1,645
Per capita (Kg)	55	88	77	92
Barley				
Production (000 tons)	1,138	2,262	1,986	2,860
Exports (000 tons)	43	101	-	89 2/
Domestic supply (000 tons)	1,095	2,161	1,986	2,949
Per capita (Kg)	95	145	118	164
Maize				
Production (000 tons)	397	384	381	492
Exports (000 tons)	75	17	-	32 2/
Domestic supply (000 tons)	322	367	381	524
Per capita (Kg)	28	25	23	29

1/ Metric tons.
2/ Imports.

SOURCE: Adapted from Office des Changes, Statistiques du Commerce Exterieur, 1975.

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Table 8

Utilization Trend of Major Cereal Grains

Year	Population	Soft wheat	Durum wheat 1/	Barley 1/	Corn 1/
	- Millions -	- - - - - 000 Metric Tons - - - - -			
1965	13.1	618	1,009	1,190	272
1970	15.1	749	1,418	1,953	320
1975	17.5	1,675	1,204	1,585	371
1980	21.0	2,243 2/	1,325 3/	1,985 3/	326 3/
1985	24.5	2,966 2/	-	-	-
1990	27.6	3,689 2/	-	-	-

1/ No predictable trends.
2/ Based on 1968-1975 linear trend. From two-year moving average, y = 509.16 + 144.54 (year-1968), (R^2 = .928) where y is tonnage utilized (000 metric tons).
3/ Mean value 1965-1975.

SOURCE: Adapted from Office des Changes, Statistique du Commerce Exterieur, 1975.

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Table 9

Importation and Exportation of Major Cereal Grains[1/]

Year	Soft wheat		Durum wheat		Barley		Corn	
	Export	Import	Export	Import	Export	Import	Export	Import
	- - - - - - - - - - - - - - -			000 Metric Tons		- - - - - - - - - - - - - - -		
1959-60		93.5	165.8		35.1		99.6	
1960-61	4.9	257.9	40.5		22.5	67.3	53.3	
1961-62		496.5	22.1			313.1		
1962-63		225.2	64.0		114.9		61.2	
1963-64		787.2			113.6		101.8	4.0
1964-65		314.5			15.7		50.6	6.0
1965-66		304.8			4.9		24.1	5.0
1966-67		854.3		40.7		26.7	2.6	17.5
1967-68		906.4				5.6		6.1
1968-69		76.8	2.0		13.9		9.4	
1969-70		181.2			189.6		26.1	
1970-71		573.2		3.1	52.9	4.4		10.2
1971-72		573.9		2.8		5.5		10.7
1972-73		469.1				44.9		20.3
1973-74		983.1				19.1		33.2
1974-75		1,032.7				88.8		41.5
1975-76		1,303 2/						
1976-77		1,500 3/						

1/ Blanks indicate zero.
2/ Estimated.
3/ Projected.

SOURCE: Adapted from Office des Changes, Statistique du Commerce Exterieur, 1975.

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Table 10

Prices of Major Cereal Grains and Wheat Milling Products

Commodity	Prices 1/	
	DH/MT	U.S. $/MT
Domestic soft wheat		
Price to the farmer	690	154
Price to the miller	600	134
Imported soft wheat		
Price to ONICL		
1974	890	198
1975	719	160
Soft wheat milling products		
Farine Nationale (flour)	855	191
Farine Deluxe (flour)	864.3	193
Durum Wheat		
Price to the farmer	920	205
Price to the miller	630	141
Durum wheat milling products		
Farine Nationale Durum (flour)	900	200
Semolina	1,030	230
Barley		
Price to the farmer	620 2/	138
Corn		
Price to the farmer	670 3/	149

1/ 1976-77 unless stated otherwise.
2/ Official price 400 DH/MT.
3/ Official price 450 DH/MT.

SOURCE: ONICL, 1977.

Table 11

Wheat Milled and Flour Sold by Commercial Mills during 1976 (in Quintals)1/

Mills/Region	Flour	Wheat
Groupe De Casablanca		
S.E.M.I.	276,771	345,985
Maghreb	437,161	546,500
Algerienne	268,365	341,605
Mins Du Maroc	284,231	372,740
Fassis	162,571	207,980
Modernes	358,810	452,496
Mies De Casablanca	138,120	176,030
Afriquia	149,575	187,029
Sahara	178,352	227,556
Ain Chok	105,427	130,072
El Fath	113,733	145,972
Royale	78,292	100,000
Rachad	53,987	67,538
Berrechid	265,272	322,322
Mohammedia	210,721	261,750
El Jadida	252,370	331,434
Oued Zem	123,201	154,764
Subtotal	3,456,962	4,371,774
Groupe De Rabat		
Baruk, Rabat	459,872	581,361
Littoral, Rabat	245,126	309,670
Kenitra, Kenitra	116,489	149,774
El Gharb, Kenitra	35,297	46,270
Nationale, S. Kacem	107,455	141,985
Andalousia, S. E. Arba	141,358	185,307
Subtotal	1,105,598	1,414,367
Groupe De Meknes		
Mins De Meknes	387,484	479,245
Sahara, Meknes	259,848	331,050
Zerhoun, Meknes	202,964	253,097
Ismailia, Meknes	109,736	135,137
Atlas, Meknes	17,734	22,200
Essaadyines	26,679	34,299
Subtotal	1,004,446	1,255,028

Continued

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Table 11 (continued)

Mills/Region	Flour	Wheat
<u>Groupe De Fes</u>		
Zalagh	202,379	251,172
Idrissia	163,852	207,534
Fejjaline	160,825	201,642
Andalousia	131,083	170,832
Oued El Jawaher	44,135	56,760
Najah	43,158	54,750
Bab Guissa	17,184	21,551
Houria Oued Fes	34,730	44,116
El Moustakbal	26,070	33,500
El Baraka	15,433	19,235
El Falah	5,222	7,180
Anouar El Manar	8,547	11,118
El Amal	6,222	7,970
Essadk	4,764	6,050
Subtotal	863,606	1,093,950
<u>Groupe De L'Oriental</u>		
Beni Ensar	296,657	376,732
Rif, Oujda	189,874	239,901
G. Mins D'Oujda	168,825	214,127
S.M.M.O., Oujda	191,642	235,341
Saada, Berkane	149,910	193,213
Mie De Taza	96,073	124,860
Isly, Oujda	161	200
Subtotal	1,093,143	1,384,375
<u>Groupe Du Nord Ouest</u>		
Detroit, Tanger	150,934	195,816
Mies De Tanger	163,939	204,919
El Fellah, Tanger	80,117	103,379
Saidia, Tetouan	113,070	143,580
Sidi Mandri, Tetouan	107,494	137,600
Lukus, Larache	73,303	91,242
Alcazar, Larache	132,164	165,875
Subtotal	821,023	1,042,414
<u>Groupe Du Sud</u>		
Baruk, Marrakech	270,636	332,716
Abbassia, Marakech	171,133	218,255
Redouane, Marrakech	174,500	218,802
Gueliz, Marrakech	91,525	111,303
G. Mins De Safi	233,004	298,133
S. Magdoul, Essaouira	91,078	120,301
Subtotal	1,031,877	1,299,511

Continued

Table 11 (continued)

Mills/Region	Flour	Wheat
Groupe D'Agadir		
G. Mins D'Agadir	396,536	494,020
El Atlas, Ait Melloul	220,260	274,322
Subtotal	616,796	768,342
TOTAL (65 mills)	9,993,454	12,629,763

1/ 1 quintal = 100 kg. or 0.1 metric ton.

SOURCE: Comite Professionel de la Minoterie, 1976.

Appendix C-1

Table 12

Regional Distribution of Bakeries, Pasta and Couscous Manufacturers, and Biscuit Makers, 1973

Province	Bakers	Pasta and Couscous Manufacturers	Biscuit Makers
Nador	59	0	2
Oujda	65	3	0
Taza	10	1	0
Fes	16	2	0
Meknes	20	1	0
Ksar Es Souk	11	0	0
Tanger	30	1	2
Tetouan	34	2	1
Larache	15	1	0
Kenitra	22	0	2
Rabat	48	2	1
Casablanca	109	11	9
El Jadida	11	0	0
Oued Zem	17	0	0
Marrakech	16	4	0
Ouarzazate	6	0	0
Safi	6	1	0
Essaouira	7	0	0
Agadir	67	0	0
Total	569	29	17

SOURCE: ONICL, 1973.

Appendix C-1

Table 13

Quantity of Cereals and Cereal Foods Consumed
Per Capita Per Year (Kg), 1971 1/

Cereal and Cereal Food	Urban		Rural	
	Auto-consumption	Commercial purchase	Auto-consumption	Commercial purchase
Whole grain	0.01	28.27	0.41	68.19
Purchased bread	0	14.40	0	2.23
Flour & semolina	2.75(3.23)	85.18(100.21)	103.95(122.29)	37.03(43.56)
Couscous	0.01	1.31 (1.74)	0.70 (0.93)	0.40 (0.53)
Pasta	0	3.99 (5.32)	0	2.15 (2.86)
Other foods	0	5.48 (4.68)	0	4.02 (4.02)

1/ Numerals in parentheses are grain equivalents.

SOURCE: Consumption and Household Expenditures in Morocco. IV. Food and Nutrition, 1970-1971. Director of Statistics.

Table 14

Quantity of Soft and Durum Wheat Consumed Per Capita Per Year (Kg. grain equivalents), 1971 1/

Wheat Type	Urban		Rural	
	Auto-consumption	Commercial purchase	Auto-consumption	Commercial purchase
Soft	0.02	71.04(99.9%)	28.89	2.64(8.4%)
Durum	2.73	71.70(96.3%)	37.96	53.03(58.3%)

1/ Numerals in parentheses represent percentages of total wheat type consumed.

SOURCE: Consumption and Household Expenditures in Morocco. IV, Food and Nutrition, 1970-1971. Director of Statistics.

Appendix C-1

Table 15

Production and Exports of Pulses, Select Years

Variety	Production: Annual average 1971-72 through 1975-76	Production: 1975-76	Exports 1975
	Metric Tons		
Fava beans	248,850	230,120	5,215 1/
Chickpeas	77,710	51,050	22,586
Lentils	26,910	41,280	13,603
Green peas (dry)	86,810	112,180	32,164
Other 2/	43,690	61,470	45,630
Total	483,970	496,190	119,198

1/ Beans for seed.
2/ Includes bitter vetch (black peas), fennugreek, and bush beans.

COMPILED FROM:

Ministere De L'Agriculture Et De La Reforme Agraire, Division Des Affaires Economiques, Royaume Du Maroc, Principales Productions Vegetales -- Campagne 1975-76, Oct. 1976.

Ministere De L'Agriculture Et De La Reforme Agraire, Division Des Affaires Economiques, Royaume Du Maroc, Les Legumineuses, May 1976.

Appendix C-1

Table 16

Prices for Select Pulses, 1975

Variety	Average price received by producer	Export price
	-Dirhams per metric ton-	
Fava beans	660	1,040 1/
Chickpeas	840	1,310
Lentils	1,090	1,616
Green peas (dry)	610	800

1/ Beans for seed.

COMPILED FROM:

Ministere De L'Agriculture Et De La Reforme Agraire, Division Des Affaires Economiques, Royaume Du Maroc, Prix Payes Aux Producteurs De 1968-69 and 1974-75, Feb. 1977.

Ministere De L'Agriculture Et De La Reforme Agraire, Division Des Affaires Economiques, Royaume Du Maroc, Analyse Du Commerce Exterieur Agricole Marocain 1969-1975, March 1976.

Appendix C-1

Table 17

Production and Imports of Oilseeds, Select Years

Oilseed	Production: Annual average 1971-72 through 1975-76	Production: 1975-76	Imports: 1975	Imports: 1976
	Metric Tons			
Sunflower	17,810	15,540	-	-
Peanuts	11,470	12,760	920	398
Flaxseed	3,030	350	-	-
Cottonseed 1/	13,130	9,650	8,118	N.A.
Soybean	-	23	6,965	16,213
Rapeseed	-	-	--	18,120
Safflower	200	-	--	-

1/ Seed cotton x .634.

COMPILED FROM:

Ministere De L'Agriculture Et De La Reforme Agraire, Division Des Affaires Economiques, Royaume Du Maroc, Principales Productions Vegetales -- Campagne 1975-76, Oct. 1976.

Foreign Agricultural Service, USDA, Report of the Agricultural Attache, Rabat, Morocco: MO-7016, March 30, 1977.

Appendix C-1

Table 18

Production and Exports of Oilseed Meals, 1975 and 1976

Type of meal	Production 1975	Production 1976	Exports 1975 1/
	- - - Metric Tons - - - -		
Soybean	10,377	9,974	-
Rapeseed	0	9,650	2,396
Sunflower seed	3,824	5,969	2,042
Cottonseed	4,486	3,175	2,812 2/
Flaxseed	1,443	929	2,570
Total	20,130	29,697	9,820

1/ Includes carryover from previous year.
2/ 1974 exports.

COMPILED FROM:

Foreign Agricultural Service, USDA, Report of Agricultural Attache, Rabat, Morocco: MO-7016, March 30, 1977.

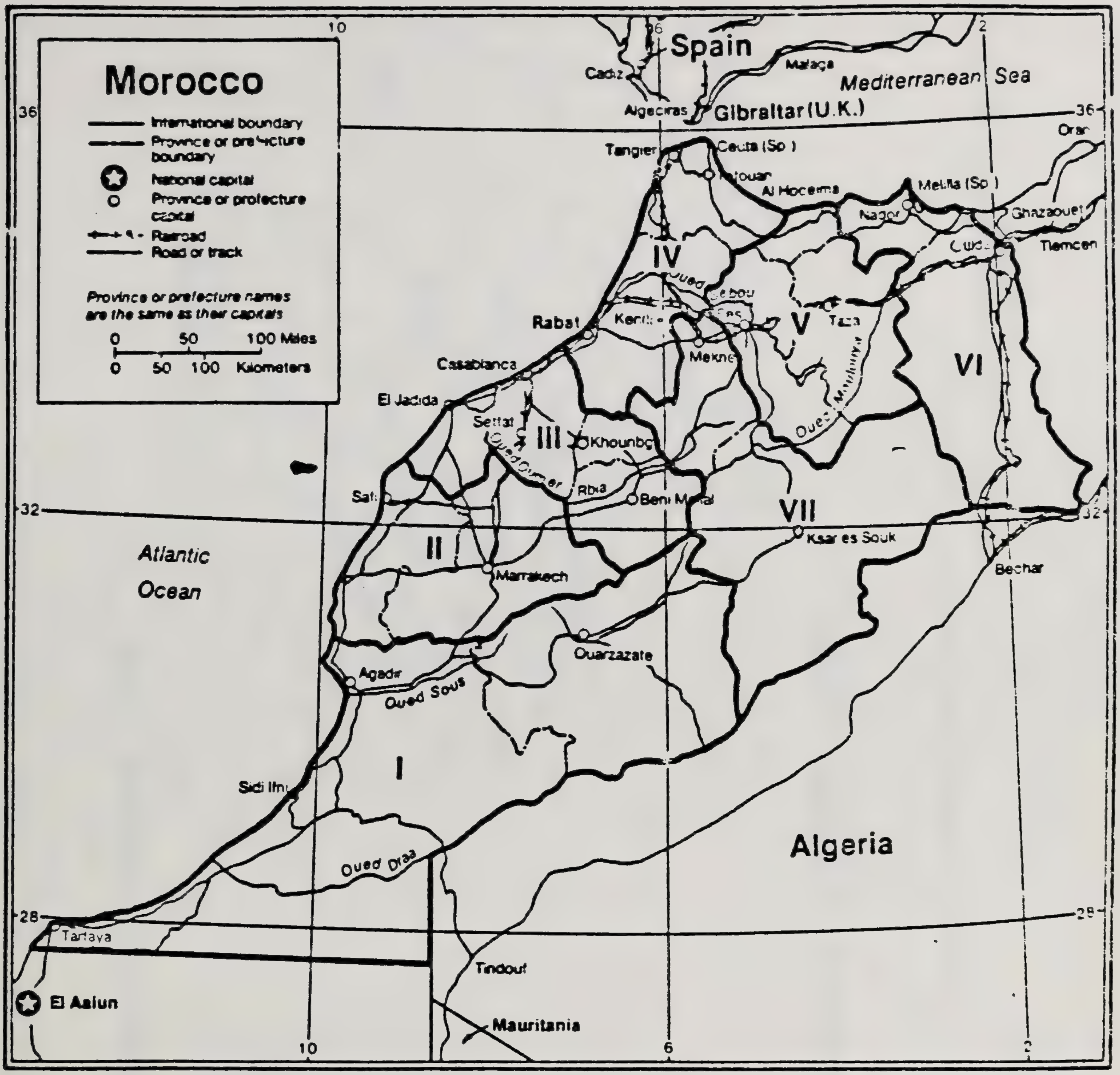
Ministere De L'Agriculture Et De La Reforme Agraire, Division Des Affaires Economiques, Royaume Du Maroc, Analyse Du Commerce Exterieur Agricole Marocain 1969-1975, March 1976.

Table 19

Parameters for Selection of Provinces for Fortification of Flour

Province or Prefecture	Population	Population urban/rural ratio	No. of commercial mills	No. MT flour sold by commercial mills	No. of kg. flour sold per capita by commercial mills	Percent of population residing in Bidonvilles	Socio-economic region in greatest need	Percent PCM 1/2 to 4 years moderate + severe	
								Province	City
	(1976)	(1975)	(1976)	(1976)	(1976)	(1971)	(1971)	(1972)	
Tangier	326,921	3/1	3	39,499	121	15		24	26
Rabat-Salé	816,766	6/1	2	70,500	86	18 Rabat 17 Salé 19.8		34	34
Kenitra	1,111,246	1/2	2	15,178	14	20		41	38
Agadir	899,930	1/4	1	39,654	44	11.5	Region I	56	40
Safi	610,648	1/2	1	23,300	38	-		45	39
Essaouri	403,275	1/7	1	9,108	23	-		-	-
Tetouan	620,147	1/1	2	22,056	35	9.4		41	37

Economic Regions



I Agadir - Tarfaya - Ouarzazate - Tiznit
II Marrakech - Safi - Essaouira - El Kelaa - Azilal
III Casa Pref. - El Jadida - Settat - Khouribga - Beni Mellal
IV Rabat Pref. - Kenitra - Tanger - Tetouan - Chaouen, Khemisset
V Fes - Taza - Al Hoceima
VI Oujda - Nador - Figuig
VII Meknes - Ksar es Souk - Khenifra - Boulmane

Figure 1

PERCENT OF HOUSING AS BIDONVILLES - BY PROVINCE

Morocco by Province 1976

SOURCE: Recensement General de la Population et de l'Habitat. 1971.

Figure 2

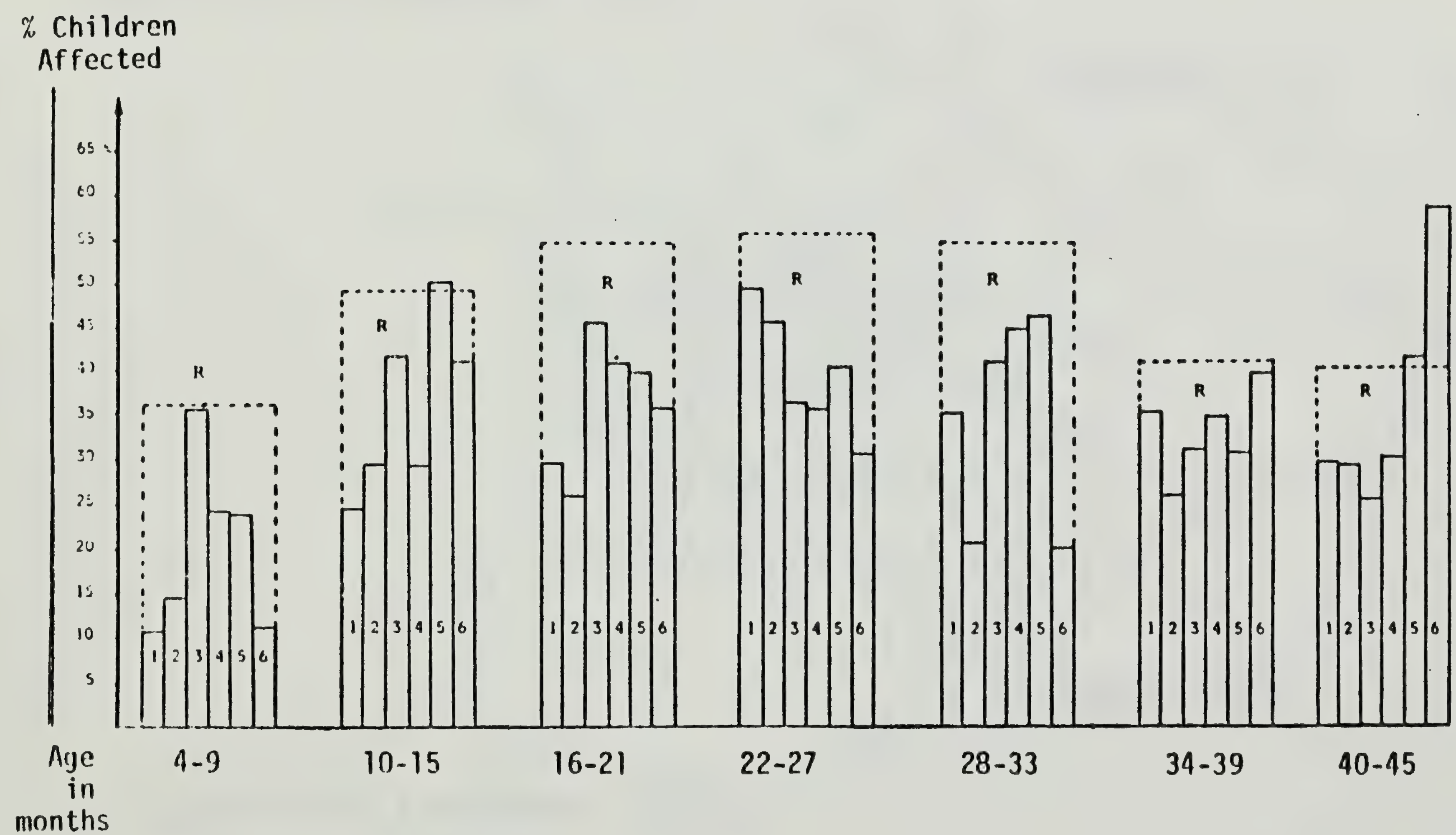
PERCENT OF HOUSING AS BIDONVILLES - BY CITY

Morocco by Province 1976

SOURCE: Recensement General de la Population et de l'Habitat. 1971.

Figure 3

VARIATIONS IN THE RATE OF PROTEIN-CALORIE MALNUTRITION FOUND ACCORDING TO AGE GROUP AND AREA OF RESIDENCE WITHIN URBAN AREAS AND COMPARED TO RURAL AREAS



R = Rural
1 = Upper Class
2 = Middle Class
3 = Old Medina
4 = New Medina
5 = Bidonvilles
6 = Housing Project (Semi-Urban)

SOURCE: Ministry of Public Health. 1973. Bulletin of Public Health No. 54. Rabat.

Figure 4

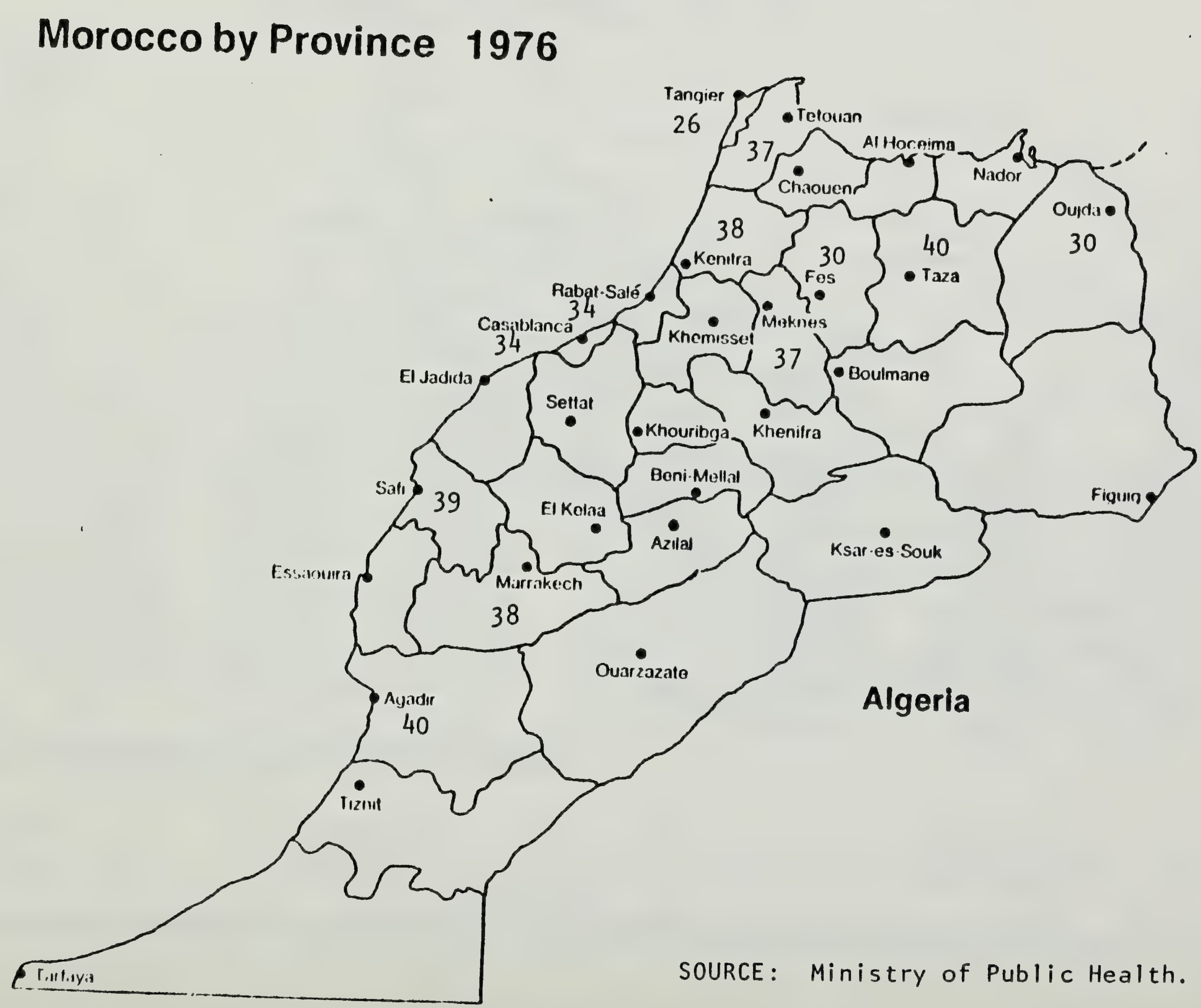
PERCENT CHILDREN <4 YEARS SUFFERING FROM MODERATE AND SEVERE MALNUTRITION
BY PROVINCE

Morocco by Province 1976

SOURCE: Ministry of Public Health. 1972.

Figure 5

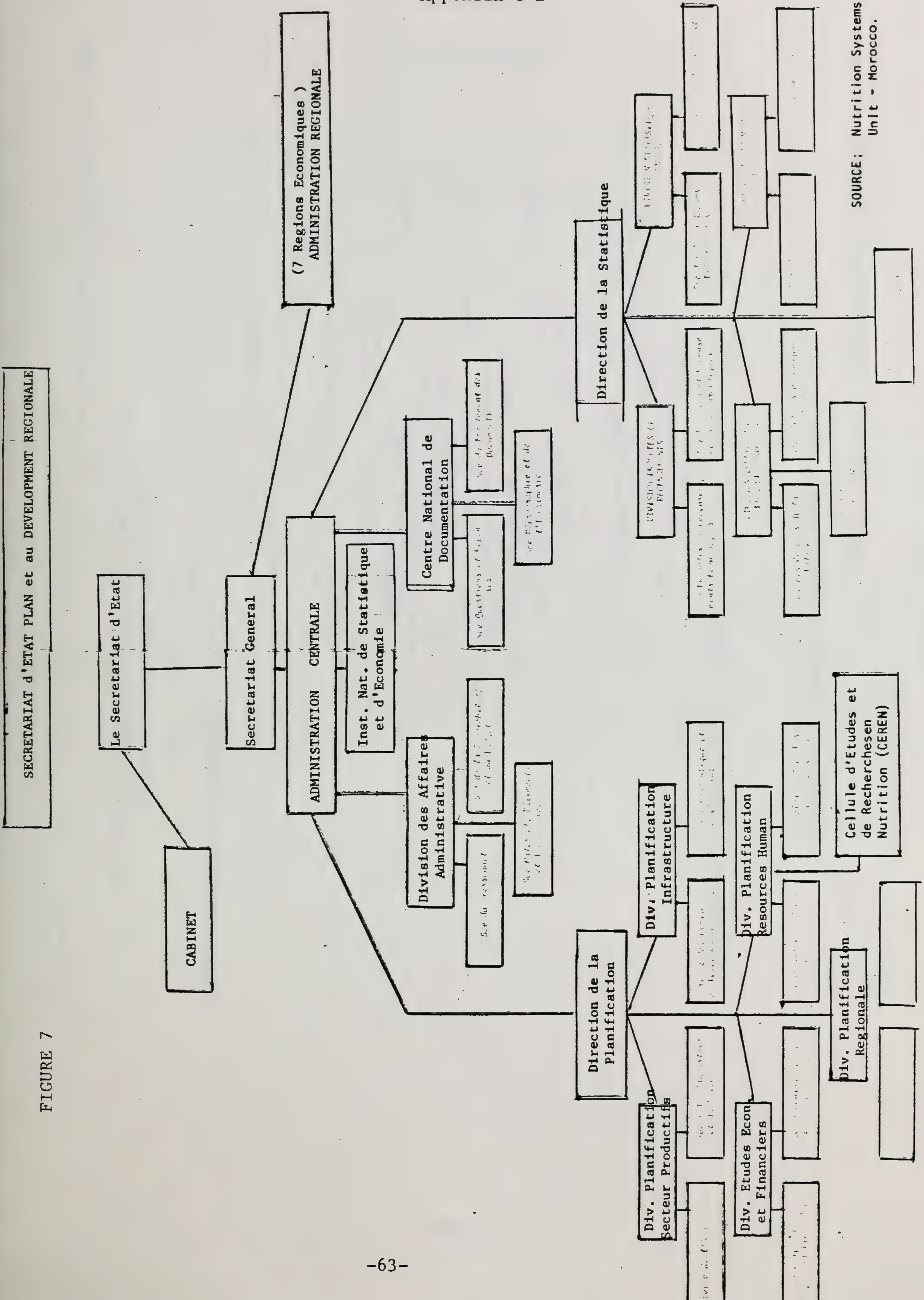
PERCENT CHILDREN < 4 YEARS SUFFERING FROM MODERATE AND SEVERE MALNUTRITION
URBAN SECTOR



SOURCE: Ministry of Public Health. 1972

Figure 6

FIGURE 7



SOURCE; Nutrition Systems Study Unit - Morocco.

DISTRIBUTION OF COMMERCIAL WHEAT FLOUR MILLS

Morocco by Province 1976

SOURCE: Comite Professionel de la Minoterie. 1976.

Figure 8

QUANTITY OF WHEAT FLOUR SOLD BY COMMERCIAL MILLS
(kg/capita/annum) BY PROVINCE

SOURCE: Comite Professionel de la Minoterie. 1976.

Figure 9

Appendix C-2

PROPOSAL FOR A WHEAT FORTIFICATION PROJECT IN MOROCCO

I. PROJECT PROPOSALS

A. Fortification of bread flour in one province with B vitamins, calcium and 5% soy flour. On the basis of various parameters for selection (table attached), explore possibilities with Rabat-Salé, Safi, Tangier and Agadir.

August 1977

1. Determine GOM support/commitment to project. Elicit responses from Ministry of Agriculture (ONICL, Professional Flour Millers Association, specific miller(s) involved, SEPO, Min. Plan (CEREN, RTI, AID), Ministry of Public Health, and Secretary of State for Economic Affairs.

Fall 1977

2. Presentation of proposal by Rassifi and carry through to meeting with various ministries.
3. Purchase of equipment and supplies for soy flour, vitamin/mineral addition. Soy flour would be purchased for experimental tests and acceptance.
4. Oilseed process engineer brought to SEPO for any necessary plant modifications.

Spring 1978

5. Install equipment in flour mill(s).
6. Test soy flour in breads with WRRC-INAV cooperation, as well as select commercial bakeries. Conduct preliminary consumer acceptance survey.

7. SEPO begin production of full fat soy flour.

Fall 1978

8. Flour mill begin production of soy/vitamin/mineral fortified flour.

Spring 1979

9. Evaluate project: nutritional impact, effectiveness in reaching target.

Throughout project there would be continual feedback to GOM officials in decision making positions for further application in appropriate provinces.

B. Modification of Actamine-5 to obtain a nutritionally and functionally improved product through the addition of 20% full fat soy flour to replace 20% of the chickpea. The proposed formulation would be: 28% wheat, 20% full fat soy flour, 20% chickpeas, and 20% lentils. The protein content of the soy flour is nearly twice that of chickpeas; caloric content of the soy is 15% greater than chickpeas. The chemical score of the proposed product would be 77 as opposed to 69.5 for the current product.

August 1977

1. Determine GOM and UNICEF interest/commitment to project. Elicit responses from Ministry of Agriculture, SEPO, Ministry ofPublic Health, Min. Plan and Secretary of State for Economic Affairs.

Fall 1977

2. Project proposal by Ministry of Agriculture Rassifi.

3. Soy process engineer to SEPO for possible plant modifications.

4. Purchase full fat soy flour for testing in pilot run of Actamine.

Spring 1978

5. SEPO production of test quantity of Actamine containing soy.

6. MOPH/Entr' Aide Nationale acceptance tests.

7. SEPO begin production of full fat soy flour.

Fall 1978

8. SEPO begin production of soy-containing Actamine on a commercial scale.

Spring 1979

9. Evaluation of project: Nutritional value/impact, target-effectiveness, cost.

C. Combine proposal B as a component of A, since production of full fat soy flour is a necessary prerequisite for both projects. Implementation of B could be concommitent with A or follow.

Appendix C-2

BACKGROUND

I General Situation

Morocco, population of 18,000,000, has an annual growth rate of 3.0%, whereby population doubles every 23 years. Food availability needs to double at this rate merely to maintain a "status quo" standard of living. Cities are growing more rapidly, as follows: Agadir 10%, Rabat 7.3%, Kenitra 7.0%, Casablanca 6.5%, and Safi 5.8%. Once an exporter of both bread and durum wheat, bread wheat has been imported since 1961 with >1,000,000 mT imported in 1975 and 1976. Durum has only been exported once (1968-1969) since 1963.

The government has responded to the population/food problem by emphasizing nutrition, production, and social equity in the formulation of the new Five Year Plan.

II Nutritional Status

Life expectancy is 53 years with general mortality decreasing from 18/1,000 to 16/1,000 in the past 10 years. Average infant mortality is 130/1,000 with ranges up to 150/1,000 live births. Values are estimated to be higher due to inadequate reporting. The 16.0% of the population <4 years of age have been designated the primary target group (nutritionally most vulnerable) by the Government of Morocco (GOM), Ministry of Public Health (MOPH), Entr' Aide Nationale (GOM Social Welfare Agency), Catholic Relief Services (CRS), and AID/Morocco. Pregnant and lactating women and school children are given lower priority in that order.

Appendix C-2

Targets in terms of socioeconomic groups are the poor, those living in Bidonvilles and in the RI (South) Economic Region (includes Agadir); other marginal groups include the New Medina, Old Medina, and Artisans. Average caloric and protein intake are as follows:

	Calories	Protein
<466 DH/yr	1337	37.1
466-542 DH/yr	2033	56.1
Bidonvilles	1809	51.2
RI-Southern Region	1862	56.0
New Medina	2142	59.6
Old Medina	2162	61.9
Artisans	1935	53.7

Source: 1970-71. GOM Survey. Household Expenditures. IV. Food and Nutrition.

Some 35-50% of protein is derived from cereals. Those from Bidonvilles are deficient in all nutrients studied, especially riboflavin (16.7% of requirement) and Ca++ (39% of requirement). Proportions of populations living in Bidonvilles are shown on attached maps; Kenitra, Rabát-Salé, and Tangier rank the highest.

The MOPH, 1972, surveyed some 6300 children <4 years and found moderate+severe malnutrition (PCM II and III) in from 30-40% in the cities, and 24-50% in the provinces (see attached maps). This study did not allow for cross-comparison between provinces. In urban strata,

the Bidonvilles and New Medinas contained the highest % of PCM in those 4-21 months of age.

III <u>Wheat Situation</u>

Production of durum and bread wheat was 1.5 million mT in 1975 with 1.3 million mT of bread wheat being imported. Average per capita consumption of wheat is 410 lbs. Cereal and legume production, processing, importation and exportation are under the control of L'Office National Interprofessionel des Cereales et Legumes (ONICL).

The National diet is based upon bread and oil, with 216 Kg cereal and cereal products consumed annually. Of this commercial bread, flour, and semolina make up 151.5 Kg/cap. The diet of the poor was described by Entr' Aide Nationale as bread, tea and sugar ... bread being an appropriate vehicle. According to 1971-75 World Bank data, 87 Kg of bread wheat was available/capita (191 lbs.) In the 15-year period 1959-60 to 1974-75, following increases have occurred in bread wheat.

	Magnitude	Actual Increase
	1,000 mT	
Production	1.5 X	279-> 422
Imports	23 X	43->1040
Domestic Supply	4.5 X	344->1462
Per capita (Kg)	3.1	28-> 87

There are at least 600 mills for bread flour, with 65 larger mills, all members of the Professional Flour Millers Association. The large mills process all of the imported bread wheat and small amounts of Moroccan

bread wheat. Distribution of large flour mills, by Province, is shown on the attached map. Regions with 3 or less mills are:

	Province
3 mills	Tangier
2 mills	Rabat-Salé, Kenitra, Tetouan, Larache
1 mill	Agadir, Essaouira, Safi

Quantities of bread flour sold by these select mills/per capita in the entire respective provinces are:

	lbs/capita/yr/province	
Tangier	266	
Rabat-Salé	190	(Baruh - 124)
Agadir	97	
Safi	84	
Essaouira	50	
Kenitra	30	

(see attached map).

Wheat is milled to approximately 69% for Farine Deluxe and 77-81% for Farine Nationale. In Moroccan terms: expressed as Kg flour/100 L. wheat. The latter is used in the typical round loaves. The simple formulation of flour, salt, yeast, water and sometimes sour dough starter, is typical. Bread, preferably freshly baked, is consumed at all major meals.

IV Protein Sources

The production and prices of various protein sources, wheat and wheat products are shown in attached tables. Locally available protein sources include dry broad beans, chickpeas and lentils (more than 50% of these three commodities were exported in 1974), and soybean cake - Societe d' Exploitation des Products Olegineaux (SEPO).
The high cost of imported soybeans is due to import and other taxes. Mohamed Benamou and Ahmed Alaoul Abdellaoui, Secretary of State for Economic Affairs, suggested a sympathetic ear would be lent to projects directed toward improving Actamine-5; and lowering, or removing, taxes on imported soybeans. Two oilseed processing plants, SEPO (72,000 mT capacity) and SIGO (120,000 mT capacity) are located in Casablanca and Kenitra, respectively.

V In-Country Project Management

The broad objectives of WRRC/AID project could be incorporated into the New Five Year Plan. Morocco is interested in as effective nutritional improvement component of the plan which stresses social equity. Close cooperation with A. Benrida and Cellule d'Etudes et de Recherches Nutrition (CEREN) exists; a relationship which should be mutually beneficial (see diagraph). AID/Morocco and their contractor, Research Triangle Institute, are intimately involved in CEREN. AID/Morocco suggested that they would be willing to seek additional funds to supplement WRRC/AID Project (advertising, marketing, etc.) if necessary.

The logistics of presenting proposals to the GOM are shown in the attached schematic diagram.

Suggested project manager counterpart would be Mr. Rassifi (Ministry of Agriculture) or one of his close associates with equivalent political clout. The relationship of the Ministry of Agriculture with ONICL, SEPO, and the National Institute of Agronomy and Veterinary Science (INAV).. suggested research sector of in-country personnel, should result in an effective relationship (shown on attachment).

VI <u>Positive Aspects of Proposed Morrocan Project</u>

A. Bread is an integral part of diet - since the poor eat large quantities, it is an effective vehicle for nutrient fortification.

B. The presence of two oilseed processing plants in country - SEPO is very interested in producing edible soy flour.

C. Close cooperation between WRRC/AID and GOM Min. Plan, Nutrition Planning Unit, (RTI, AID), and AID staff. AID/Morocco volunteered to seek additional funds to supplement WRRC project for massive advertising and implementation.

D. The New Five Year Plan will stress social equity with nutritional emphasis. The broad objectives of WRRC/AID Project could be included.

E. Regionalization of governmental responsibility, fiscal management, and program direction will be emphasized in the New Plan. Select fortification of flour mills in one or a few provinces would complement this strategy.

F. Technical and political capabilities of the in-country management team and industry are on a level which could allow for the implementation of a project such as WRRC/AID.

Appendix C-2

PRODUCTION
(metric tons)

	1975		1974		Export 1973-74	Import 1973-74	
Lentils			15,000	F			
Chickpeas	60,830	G	80,000	F	185,500		
Dry Broad Beans	212,680	G	200,000	F			
Dry Peas			40,000	F			
Cottonseed			23,000*		400*		
Groundnuts (in shell)			13,000*				
Rapeseed						3,300	F
Soybean (see additional data in table below)						260	F
Sunflower			14,000*				
Sorghum			39,000*				

Wheat	1975	1974-75	Imports 74	Imports 75	Imports 76
Tendre	371,000	423,000	983,167	(1,303,634)	1,300,000
Durum	1,203,980	1,340,389			

(all figures GOM)

Soybeans	1975	1976	75	76
Soybeans			6,965	16,213
Meal (exported)	10,377 (7,000)	9,974		

(all figures GOM)

G - GOM Statistics
* - Unofficial Figures
F - FAO Estimate

Appendix C-2

PRICES

(U.S. $/metric ton)

Fava Beans (74/75)	147		
Chickpeas			
Wholesale (5/76)			
Bulk (SEPO)	200-295		
Bagged (SOCOPROS)	318		
ONICL (quality/size)	205-340		
GOM (74/75)	186		
Retail (Rabat 5/76)	450		
Lentils			
Wholesale (5/76)			
Bulk (SEPO)	200-295		
Bagged (SOCOPROS)	285		
ONICL (quality/size)	273-309		
Retail (Rabat 5/76)	350-450		
Soybeans			

World Market Prices
C.I.F. European ports

Soybeans A. Holz FAS 6/14/77	261 (6/76)	332 (6/77)	
Meal (44% protein) "	234 (6/76)	260 (6/77)	
Meal (Oct-Feb Ave.)	162 (75/76)	274 (76/77)	
Imported Soybeans (Morocco) C.I.F. Casablanca (GOM)	267*(74)	329*(75)	408*(77)

*Includes 2.5% import duty and 20.5% other taxes.

Appendix C-2

PRICES

(U.S. $/metric ton)

Wheat		
Bread wheat		
To Farmer	153	(74-75)
Imported	200	(74)
	162	(75)
By Miller	133	
Durum	140	
Barley	89	
Corn	100	
Flour		
Nationale	190	(77)
Deluxe	192-200	(77)
Wheat Bran	55	

Appendix C-2

INTRODUCTION OF PROPOSAL

Ministry of Agriculture
Mohamad Rassifi, Chief, Economics Division

Prime Minister

Secretary of State for Economic Affairs
Mohamed Benamou,
Ahamed Aloul Abdellaoui

Call meeting of all relevant ministries

Min. Plan

Ministry of Planning and Economic Affairs

Secretariat

Director of the Plan
Mohamed Bijaad

Division Chief, Human Resources, Development and Nutrition
Ahmed Benrida

CEREN - RTI
Abraham David
M. Roulison

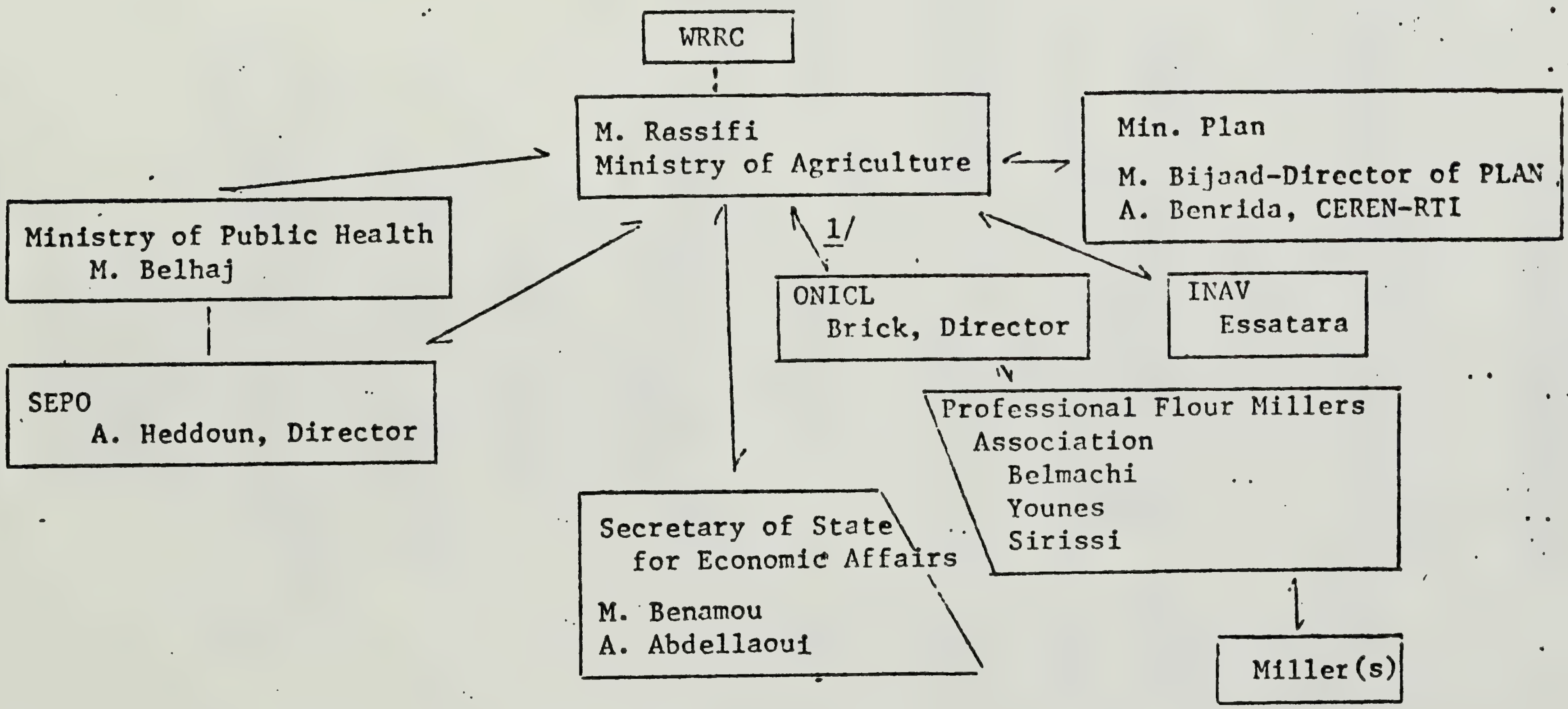
Ministry of Agriculture

ONICL

SEPO (Actamine)

INAV

TENTATIVE PROJECT MANAGEMENT INTERRELATIONSHIPS



1/ If Flour Bread Project is selected.

WRRC will have direct relationships with all of the cooperators.

PARAMETERS FOR SELECTION OF PROVINCES FOR FORTIFICATION OF FLOUR

	Population X 1000	Pop. urban/rural ratio	No. of commercial mills	No. mT flour sold by commercial mills	No. lbs. flour sold per capita by commercial mills	% of population residing in Bidonvilles	Socioeconomic Region in greatest need	% PCM 0-4 years Moderate + severe Province	City
	(1976)	(1975)	(1976)	(1976)	(1976)	(1971)	(1971)		
Tangier	326,921	3/1	3	394,990	266	15		24	26
Rabat-Salé	816,766	6/1	2	704,998	190	18 R-17 S-19.8		34	34
Kenitra	1,111,246	1/2	2	151,786	30	20		41	38
Agadir	899,930	1/4	1	396,536	97	11.5	Region I	56	40
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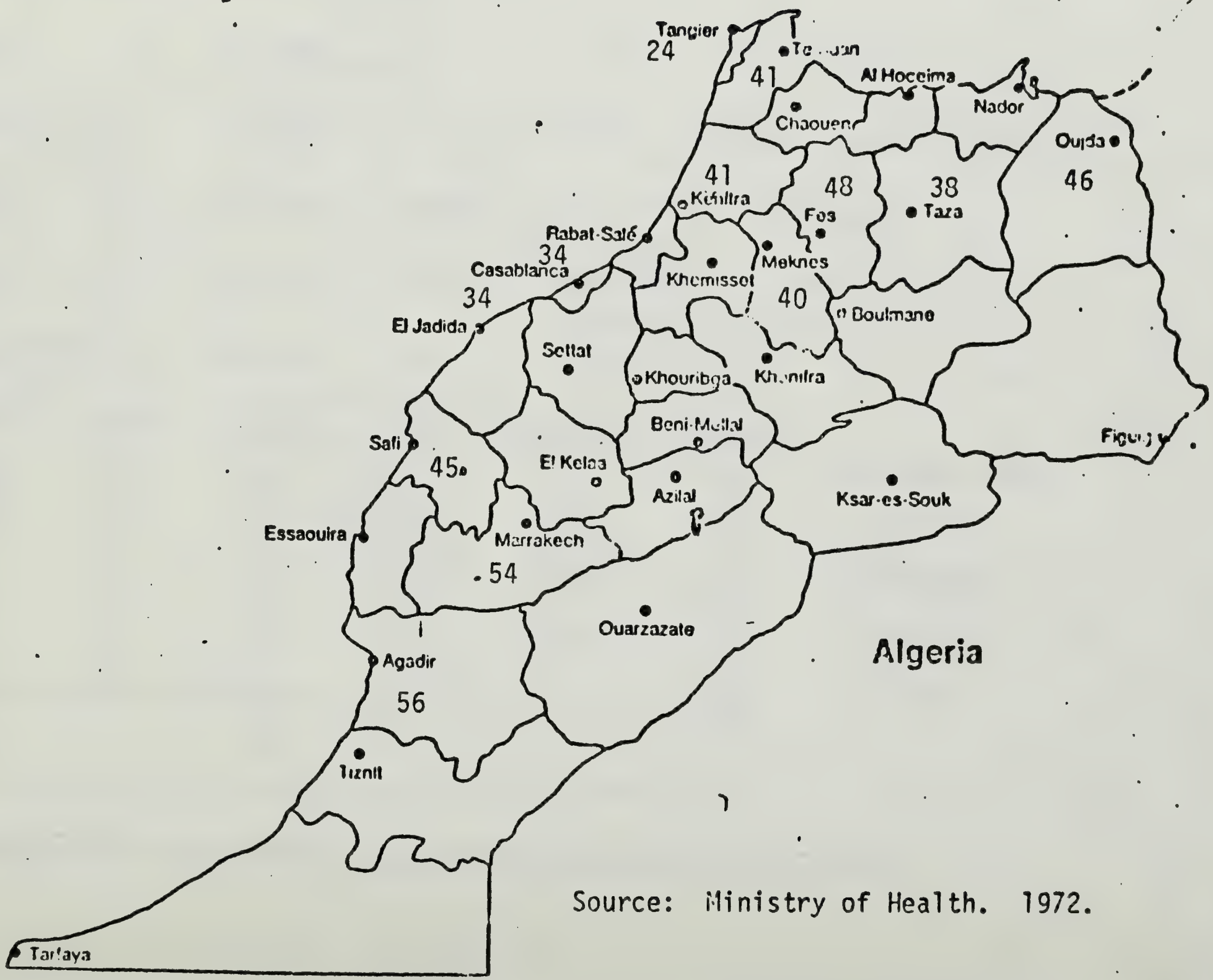
Essaouri	403,275	1/7	1	91,078	50	-		-	-
Tetouan	620,147	1/1	2	220,564	78	9.4		41	37

PER CENT CHILDREN < 4 YEARS SUFFERING FROM MODERATE AND SEVERE MALNUTRITION
BY PROVINCE

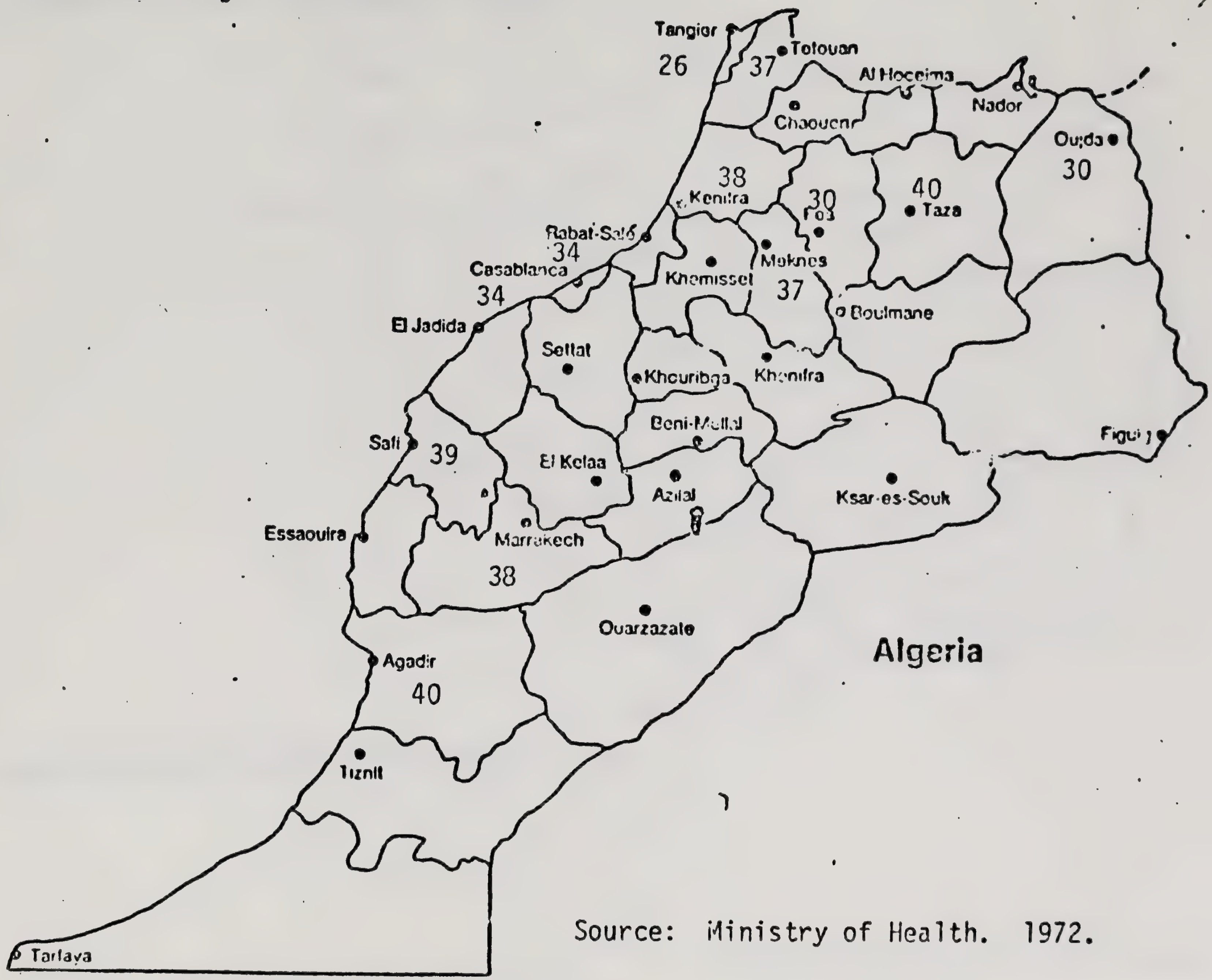
Morocco by Province 1976



Source: Ministry of Health. 1972.

PER CENT CHILDREN < 4 YEARS SUFFERING FROM MODERATE AND SEVERE MALNUTRITION
URBAN SECTOR

Morocco by Province 1976



Source: Ministry of Health. 1972.

Appendix C-2.

DISTRIBUTION OF LARGE WHEAT FLOUR MILLS

Morocco by Province 1976

Source: Comite Professionel de la Minoterie. 1976.

QUANTITY OF WHEAT FLOUR SOLD BY COMMERCIAL MILLS
(pounds/capita/annum) by province

Morocco by Province 1976

Source: CERED - Ministry of Plan and
Comite Professionel de la Minoterie. 1976.

Appendix C-2

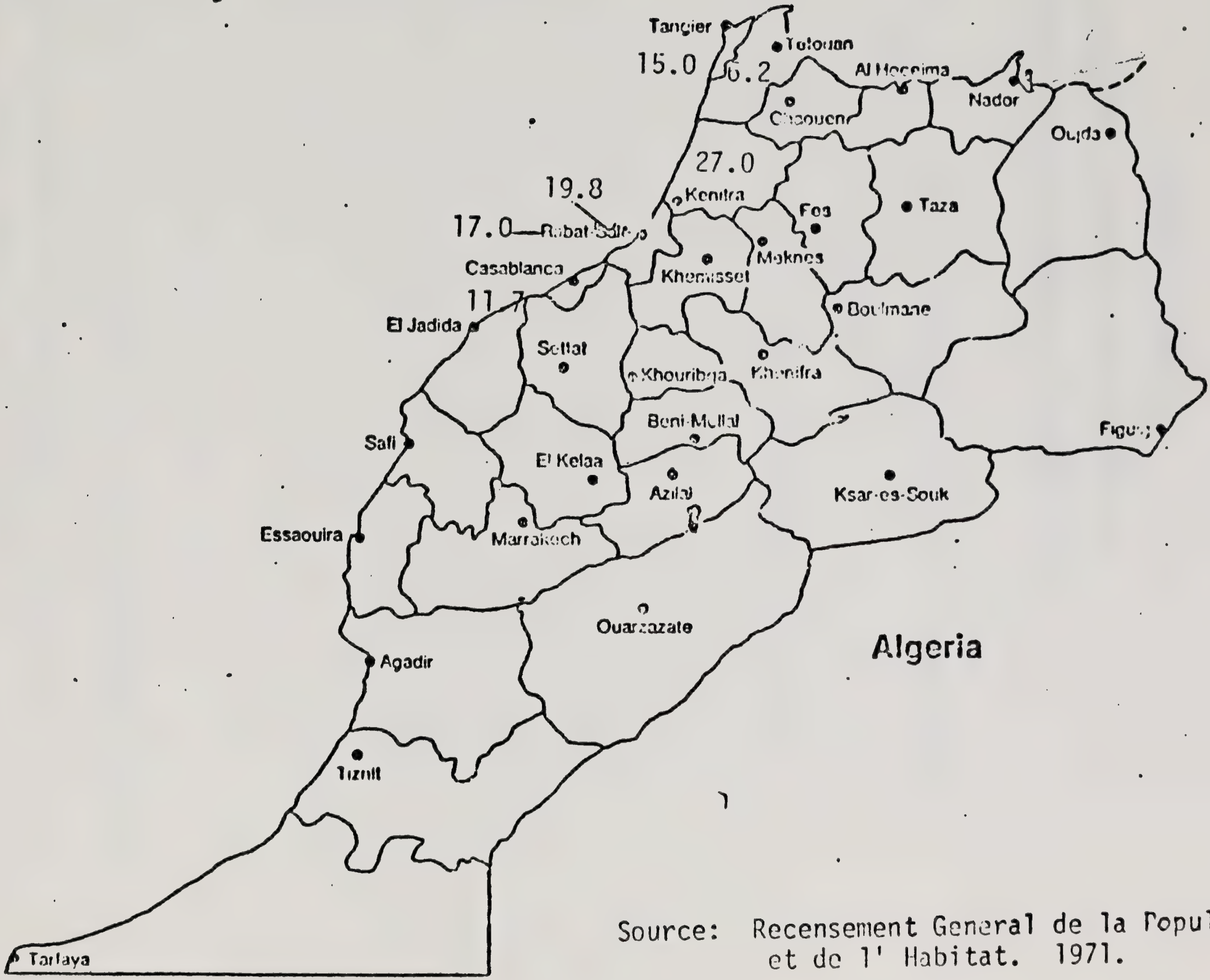
PER CENT OF HOUSING AS BIDONVILLES - BY PROVINCE

Morocco by Province 1976

Source: Recensement General de la Population et de l' Habitat. 1971.

Per Cent of Housing as Bidonvilles - by City

Morocco by Province 1976



Source: Recensement General de la Population et de l' Habitat. 1971.

COMPOSITE FLOURS

Ecuadorian Situation October 1980 and Comments and Information on Feasibility[a]

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COMPOSITE FLOUR: ECUADORIAN SITUATION OCTOBER 1980

AND COMMENTS AND INFORMATION ON FEASIBILITY

INTRODUCTION:

The consumption of wheat flour in Ecuador has increased from 31.5 lbs. in 1963 to 63 lbs. per capita in 1978.[1/] A consumption of 63 lbs. of wheat flour provides 12 to 15 percent of the total dietary calories. Undoubtedly, per capita consumption is substantially higher in urban areas and lower in rural areas. The trend toward increasing per capita consumption continues.

The percentage of imported wheat has risen from a low of 52.6 percent in 1968 to 92.1 percent in 1978.[1/] One can conclude that Ecuador has developed a dependence on the World Wheat Market for a major component of its national diet.

There are basically 5 approaches to reducing wheat imports:

1. Increase National Production.
2. Decrease demand by increasing the consumer price.
3. Reduce import quotas; promote local foods.
4. Use of composite flours.
5. Increase the flour extraction rate.

In June 1980, the Government of Ecuador (GOE) raised the farmer price of national wheat to $US 290/MT (330 S/qq)[a] from $US 220/MT (250 S/qq) delivered to the wheat mill, a price somewhat above imported wheat, in an attempt to stimulate production. However, since wheat is grown primarily in the Sierra where excess land is not abundant, any

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a) An official exchange rate of 25 Sucres/$US is used in this document.
qq = quintal = 100 pounds

shift to wheat production is likely to be at the expense of the other Sierra crops such as barley (also heavily imported), soft corn, potatoes, etc.

Increasing the price of wheat flour is politically difficult, especially a single large increase that would tend to dampen demand. The largest users of wheat products are urbanites that can display public opinion rapidly and intensely. The GOE has not instituted any consumer price increase on wheat flour since 1973 when the S/253 per qq was established. To maintain price, the GOE subsidizes wheat flour. The subsidy has risen sharply in 1980 and is currently (October 1980) near S/190 per qq.

Reduced import quotas are also politically difficult. Demand would reamin high and scarcities would develop unless prices were raised substantially at the same time. In addition, the wheat millers are a very influencial group and would resist reduced import quotas.

Composite flours appear to be more politically acceptable and in addition can be a vehicle for improving the nutritional quality of wheat products. Producer and processor groups of local crops to be substituted into wheat flour are very supportive and often willing to risk capital. Even so, the most difficult aspect of establishing a composite flour program in a developing country is the creation of a stable, high quality, attractively priced, domestic supply of the non-wheat flours to be used. Wheat millers and bakers are generally skeptical about composite flours since such flours only complicate their work and there is little or no financial incentive (sometimes negative incentives) offered to solicit their support.

A mandatory increase in extraction rate of flour from 75 percent to 82 percent, as is the case in Peru, could increase the recovery of flour from 75 lbs. per qq of wheat to 82 lbs. 1981 wheat imports could then be reduced 27,317 MT (based on 240,000 MT wheat flour for 1981). Bread would have a definite brownish cast but vitamin and mineral content would be substantially improved. As proved in Peru, acceptability is quite adequate. To the extent that wheat flours prices are higher than wheat millfeeds, the increased extraction rate would reduce the per unit cost of flour.

COMPOSITE FLOUR STUDIES IN ECUADOR:

Kansas State University in conjunction with USAID, GOE, and the private sector carried out an extensive composite flour study[2/] in 1974-1976 with the recommendation of adding 12 percent defatted soy flour to wheat flour. At the time, there was insufficient soy production and no food grade soy flour processing capacity. The project recommendation was not implemented.

However, interest in composite flours continued. The Ministry of Agriculture (MAG), Escuela Politecnica Nacional at Quito (Elman Lopez; Project Leader) and Centro de Desarrollo Industrial del Ecuador (CENDES) have collaborated on the continuing program of composite flours. They broadened the view of composite flours to include studies on the potential of yuca, corn, rice, potato and quinua as well as soy.

Many reports (see Appendix A for list) on technical laboratory studies, commercial bakeries trials and consumer acceptance studies on breads and pasta made from composite flours have been prepared by the Escuela Politecnica Nacional (EPN). Technically speaking, all the commodities proved acceptable in breads at various levels.

More recently, it became necessary to narrow the field in commodities that might be used in a composite flour program. It appears that the basic criteria that emerged for this narrowing process were:

1. Lowest price for the non-wheat flour.
2. Availability or potential availability of the selected commodities.
3. No reduction in nutritional quality (protein level).
4. Maximum substitution based on:
    a) Technical feasibility studies.
    b) No use of bread improvers in the blend.
    c) Consumer acceptance.

With respect to price, CENDES, in an April 1980 report[3/] on the economic evaluation of composite flour, concluded that corn was the only commodity whose price and production potential justified its use in composite flour. However, the use of corn flour in wheat flour would reduce the protein content (see Table 1) of the blend compared to wheat flour. It was concluded that this necessitates the use of a protein rich component in the composite flour formulation to offset the diluting effect of corn; soy flour was the only product filling this requirement. Thus the two commodities for composite flour decided upon are corn and soy.

Table 1

Protein Content of Various Composite Flours and the Effect on per capita Intake[a/] of Protein and Lysine in Ecuador

Composite Flour[b/]	Protein[c/] Content	Protein g/cap/day	Lysine[d/] mg/cap/day	Mg Lysine[e/] per gram Protein
100% Wheat Flour	11.0	8.62	172.4	20.0
90% WF + 10% CF	10.7	8.39	166.5	19.8
87% WF + 10% CF + 3% SF	11.9	9.31	231.9	24.9
87% WF + 8% CF + 5% SF	12.7	9.96	276.7	27.8

a. Wheat Flour consumption (1978) is 63 lbs., per capita per year (78.4g/day).

b. WF = Wheat Flour; CF = Corn Flour; SF = Defatted Soy Flour.

c. Corn Flour = 8.0 percent, defatted Soy Flour = 50 percent protein.

d. Wheat Flour: 2 percent of protein is lysine. Corn Flour: 1.8 percent of protein is lysine. Defatted Soy Flour: 6 percent of protein is lysine.

e. At these levels, lysine is the limiting amino acid as determined by the Protein Efficiency Ratio Method using weanling rats.

Since no bread improvers were to be used (cost consideration), this limited the practical substitution level to 13 percent (technical studies). With this information in hand, it is readily apparent from where the currently recommended composite flour formulation evolves.

Recommended Composite Flour Formulation
Escuela Politecnica Nacional

- 87% Wheat Flour of 75% extraction
- 10% Corn Flour at less than 2% fat (stability)
- 3% Soy Flour, defatted food grade

<u>The Question of Nutritional Justification for a Composite Flour Program</u>:

The Kansas State University-Ecuadorian wheat fortification project[2] in 1976 gave the following <u>nutritional</u> basis for soy fortification of wheat flour:

- Malnutrition exists; e.g., 40% in preschoolers
- A lower than recommended intake of protein per capita (46 grams/day)

It was recognized that information was not available on "---protein deficient groups in the population and the extent of their wheat flour consumption," but it was concluded that "--some flour is consumed by some protein deficient persons." Therefore, because they estimated little or no cost increase for soy-fortified flour, "--the program would have some nutritional benefits at little or no cost." The benefits referred to are increased protein as well as vitamins and minerals from enrichment. The question as to what degree diet is implicated in the malnutrition observed in Ecuador compared to such other factors as diarrhea, parasites, infectious diseases or nutrition education was not addressed.

The situation appears to remain the same today; adequate information does not exist to predict with confidence, the nutritional significance to the Ecuadorian population of fortifying wheat products with soy flour from either a protein quality or quantity basis. From a nutritional point of view, the selection of 3% defatted soy flour for the composite

flour by the Escuela Politecnica Nacional must be considered arbitrary. Any other level would be equally arbitrary. Conversely, one could not predict with confidence any nutritionally negative effect of adding defatted soy flour. The major justification for adding soy to wheat flour must come from other considerations such as economic considerations.

Enrichment of wheat flour with vitamins and minerals can be accomplished without resort to composite flours. Therefore, the nutritional advantages of enrichment are not considered here.

Evaluation of Recent Composite Flour Studies in Ecuador:

Mr. Jacque Faure, Food Technologist, FAO, Rome, was detailed to Ecuador for the period October 20 to November 13, 1980 to evaluate the recent composite flour studies, suggest any further studies and make recommendations. This author assisted Mr. Faure in some of the economic analyses; a copy of the Faure report is attached as Appendix B.

Soy Situation:

The uses of soy are for its 20 percent food grade oil content and its 80 percent of high protein (44 percent) residue soy cake, a product most suitable for animal feed, especially poultry.

Total food fats and oils processed in Ecuador in 1979 were 120,862 MT of which 63,424 MT were imported. Considering food oils only, Ecuador obtained 6,933 MT from domestic oilseeds in 1979 and imported an additional 29,924 MT of crude oil (largely soy) for refining. Obviously, there is no constraint on soy production because of insufficient markets for oil.

Soy cake, which results from processing the soybean for oil, is used for animal feeds and its markets have been closely matched to demand. This year, however, because of drought, soy production did not meet expectations and soy cake is in tight supply. The PNA (National Cotton and Oilseeds Program) and officers of Oleica Oilseed Processing Company at Guayaquil estimate a shortfall of 10,000 to 15,000 MT of soybeans with respect to the demand for soy cake. These officials also indicate a 20 percent yearly increase in demand for soy cake for feed.

In summary then, there is essentially an unlimited market for domestic soy oil and a tight and rapidly expanding market for soy cake as animal feed, both strong indicators for increased soy production in Ecuador.

The enhancement of soybean production and self-sufficiency in food oils is a major effort of the GOE. A substantial infrastructure, with the support of the GOE, has been built up and includes:

1. INIAP-INTSOY. Research and extension on seed selection, disease and cultural practices.
2. Growers association.
3. PNA/MAG (National Cotton and Oilseed Program) - Planning and Extension.
4. Strong, modern oilseed processing industry.
5. MAG/CENDES/Escuela Politecnica Nacional - Research on food uses of soy and soy cake.

These are all important contributions toward an expanding soybean production and utilization.

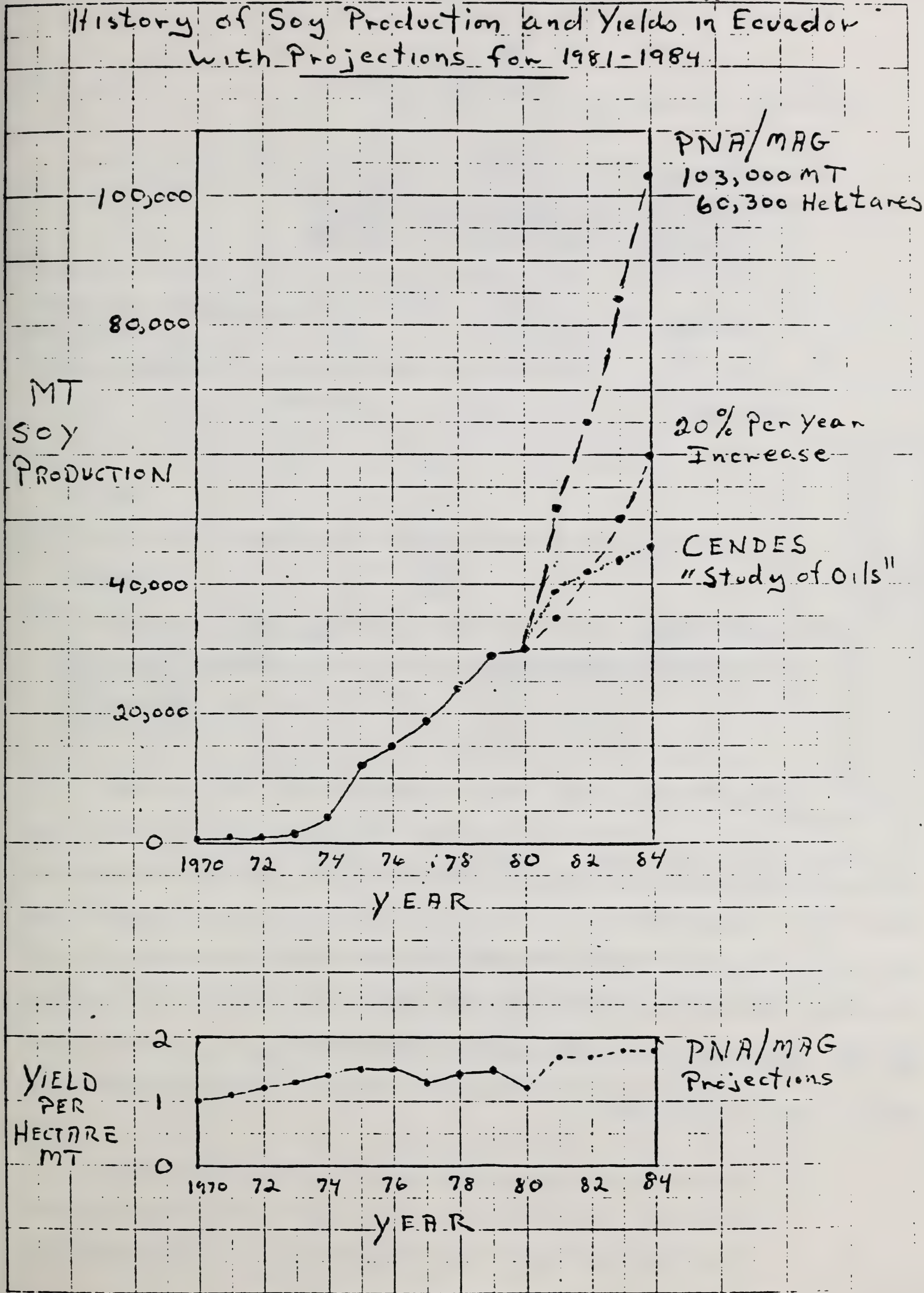
The production of soy from 1970 and projections of production to 1984 are shown in Figure 1 and Table 2. Production took a big leap from 1973 to 1975 growing from 1,538 MT to 12,324 MT and has been growing since then at a compounded rate of 20 percent per year. It appears reasonable to this reviewer that the 20 percent rate of growth will continue to 1984 yielding a production level of 60,000 MT at that time.

New land or abandoned land from other crops is said to be available for increased soy production. It appears then, that the major constraint for future production growth will be price. With regard to the current price situation, the PNA estimated production costs of soy at about $US 313/MT while the official soy price is $US 370/MT.[4/] This appears to be a reasonable return and should promote further increases in soy production in the near term.

Potential for Food Grade Soy Flour:

As part of the Kansas State University project[2/], Mr. Ross Brian, a private US consultant, was hired to determine the added equipment and modifications needed to convert the 4 Ecuadorian solvent extraction oilseed processing plants to yield food grade soy flour. In the 1976 Brian Report[5/], the cost estimates and projected food grade soy production capacity for the 4 soy processors were as follows:

FIGURE 1


History of Soy Production and Yields in Ecuador
with Projections for 1981-1984
PNA/MAG
103,000 MT
60,300 Hectares
100,000
80,000
40,000
20,000
0
MT
SOY
PRODUCTION
20% Per Year
Increase
CENDES
"Study of Oils"
1970
72
74
76
78
80
82
84
YEAR
2
1
0
YIELD
PER
HECTARE
MT
PNA/MAG
Projections
1970
72
74
76
78
80
82
84
YEAR

Appendix D

TABLE 2

History of Soy Production and Hectares
in Ecuador with Projections for 1981-1984

Year	Reference						Reference					
	a	b	c	d	e	f	a	b	c	d	e	f
	MT X 000						HA X 000					
1970	0.6						0.6					
71	1.1						0.9					
72	0.8						0.7					
73	1.5						1.2					
74	4.4						3.0					
75	12.3						8.2					
76	15.0						10.0					
77	19.3						14.8					
78		25.4		23.3				16.9		17.1		
79			27.2	29.9					22.5	20.6	22.5	
* 80				(39.7)	30.4	(36.9)				25.0	25.8	24.6
* 81					(52.4)	(39.2)					(32.0)	(26.2)
* 82					(64.7)	(41.6)					(39.5)	(27.7)
* 83					(84.1)	(46.2)					(48.8)	(29.3)
* 84					(103.9)	(46.2)					(60.3)	(30.8)

* (   ) = Projection

a. MAG, Direccion de Planificacion. "Estimacion de la Superficie Cosechada, Produccion, y Rendimiento Agricola del Ecuador 1965-1977" Marzo 1979.

b. Ibid. "1978". Marzo 1980.

c. FAS, USDA. "Annual Agricultural Situation" 1/22/80, Quito.

d. FAS, USDA. "Fats and Oils Report". 4/14/80, Quito.

e. PNA, MAG. Quoted from "Harina de Soya Para Consumo Humano" MAG-IIT November 1980.

f. CENDES. "Study of Oils" 1980.

Appendix D

Plant	1976 Soybean crushing capacity MT/24 Hr.	1976 Cost of equipment to manufacture food grade soy flour	Capacity of food grade soy flour with new equipment MT/24 hr.
Phidaygesa, Guayaquil	60-80 (115)[a/]	$500,000	80
Ales, Manta	110	700,000	77
La Favorita, Guayaquil	110	700,000	77
Oleica, Guayaquil	57 (110)[b/]	310,000	40 (77)[c/]

a. This will be the capacity at Phidaygesa if the indicated equipment is added.

b. This capacity is possible with larger flaking rolls (said to be ordered).

c. This capacity of soy flour would be possible with the larger flaking rolls and an increase in the size of the equipment for manufacture of food grade soy flour.

There have been some improvements in these plants since 1976 but none has installed all the necessary equipment for production of food grade defatted soy flour. Only Oleica was visited by this author. The new flaking rolls were installed and capacity is now 110 MT/24 hours. Oleica has also installed driers and is planning to install dehulling equipment. This would give Oleica the basic ability to provide a food grade defatted soy grit. An additional investment (est. $220,000) would be needed to produce soy flour, a program of definite interest at Oleica.

Oleica processes other oilseeds (cotton, sesame, palm) and its total capacity is not available to soy. Assuming half of its capacity would be available for soy, this would give a production capacity of

11,550 MT per year of food grade defatted soy flour, more than enough to meet the 7,200 MT needed for the 87 percent wheat flour, 10 percent corn flour, 3 percent soy flour composite flour program. (The 7,200 MT of soy flour is based on an estimated 240,000 MT of wheat flour for 1981.) The 7,200 MT of soy flour would require 10,285 MT of soybeans according to the "Brian" calculation. While National production in 1979 was 29,000 MT, Oleica received a 6,705 MT quota for domestic soybeans. If Oleica were to be the only supplier of soy flour, then the GOE would need to give Oleica a larger quota of soybeans.

A second scheme for defatted soy flour has been proposed by MAG-IIT/EPN[6/] that is very similar to the "Brian" process. They calculated a 58 percent yield of soy flour from beans as the most reasonable for Ecuador (allowing a portion of the meal to be mixed with the hulls to make a more suitable feed product.) This would require 12,414 MT of soybeans to yield the 7,200 MT of food grade defatted soy flour. The MAG-IIT/EPN study estimated new equipment costs of $505,000 for an existing 80 MT per 24 hour of soy cake plant. Production and other cost were estimated as follows: Labor S/1.55/qq of soy flour produced; operating, depreciation, supplies, insurance and miscellaneous S/11.1 qq; raw material 458.6/qq; selling expense S/8/qq; and financing S/5.14/qq. The price per qq of food grade defatted soy flour, therefore, was S/484. This does not include a credit for the animal feed by-product of S/46 which would result in a net price of S/438/qq of food grade defatted soy flour. Recent prices for soy cake, animal grade, have been S/360-380 per qq (Oleica); official price is S/380/qq.

In summary, the production of food grade defatted soy flour remains technically feasible but would require private investment by one or more of the oilseed processors and would also require the GOE to adjust soybean quotas. The removal of 7,200 MT of soy flour would aggravate an already tight feed market, but soybean production potential appears good and both food and feed demands should be met in the future.

Corn Situation and Potential for Corn Flour Production:

This commodity has not been studied in any depth in my current program of work, however, a few statistics and observation can be presented.

Table 3 gives the production costs of corn reported by the Comision MAG, April 1979. The average yield is 1039 kg/Ha and average production cost per qq is S/227.

Table 4 gives the official prices and the market prices for the years 1970-1979. The current official price is S/280/qq, a substantial increase from 1979.

FAS[7/] has estimated hard corn consumption demand at "183,000 MT (1979) when available." A review of Table 5 on the historical and projected production of corn shows that 1978 and 1979 production fell substantially short of demand. The increased 1980 price of S/280/qq has stimulated plantings and, therefore, production and demand should be in closer balance. The projections in Table 5 by the MAG, National Seed Program do not suggest any great surpluses of hard corn in the coming years. The composite flour program would require 34,285 MT of corn to yield about 24,000 MT of corn flour to meet the 10 percent addition to wheat flour (based on an estimated 240,000 MT of wheat flour for 1981.) The residue from corn flour production would be highly

suited for animal feed, thus the net increase in corn production actually required is only 24,000 MT. Even so, it appears that corn supplies will be tight and additional incentives or assistance will need to be applied to encourage greater production.

TABLE 3

Production Costs and Yield for Hard Corn

Degree of Technology	% of Land	Production Costs/Ha	Yield Kg/Ha	Cost/qq Sucres
High	3	S/ 9,153	2,273	183
Medium	27	S/ 6,901	1,591	197
Low	70	S/ 4,341	773	255
Ave	-	S/ 5,177	1,039	227

Source: Comision MAG; April 1979.

TABLE 4

Official and Market Prices for Hard Corn
1970-1979

Year	Official Price, S/qq	Market Price, S/qq
1970	-	72
71	-	62
72	120	80
73	120	140
74	143	151
75	160	164
76	160	218
77	195	242
78	203	250
79	203	254

Source: Comision MAG; April 1979.

Appendix D

TABLE 5

Hard Corn Production

Year	Production MT x 1000	Hectares x 1000	Yield Kg/Ha
1970 [a]	102	80	1,266
71 [a]	121	111	1,088
72 [a]	101	102	989
73 [a]	153	141	1,089
74 [a]	186	162	1,148
75 [a]	190	165	1,152
76 [a]	198	165	1,204
77 [a]	164	163	1,007
78 [a]	137	133	1,030
79 [b]	136	100	
80 [c]	180	168	
81 [c]	200	178	
82 [c]	214	183	
83 [c]	222	183	
84 [c]	231	183	

a. MAG "Estimacion de la Superficie Cosechada, Produccion y Rendimiento Agricola del Ecuador", March 1979. Ibed. March 1980.

b. FAS, USDA. Grain and Feed Report 8/1/80, Quito.

c. MAG, National Seed Program. Quoted from (2) above.

Appendix D

There is currently a corn processor in Latacunga making several corn products, including low fat corn grits for the beer brewing industry. Such grits, ground to a flour is the type of product suitable for composite flour. Its price of S/500/qq may be an indicator of the cost of corn flour for the composite flour program.

Oleica is in the process of constructing a 100 MT/24 hr. plant, estimated to be operational in 1981, to process hard corn for the production of raw or pregelatinized corn grits or flours. Oleica estimated a wholesale price of S/460/qq for such flours both of which would be suitable for a composite flour program. It does not appear that Oleica has adequate markets for the corn grits and flour of such a production magnitude and, therefore, substantial quantities could be generally available. The 8 percent of corn germ from the process would be used to recover oil while the 22 percent of hulls-meal would be used in animal feeds. Working 300 days per year, Oleica could supply about 21,000 MT of corn flour, not quite enough for the composite flour program with 10 percent corn flour.

In working with the FAO expert, Jacque Foure, an estimated price (at the corn mill) of S/392/qq of low fat (less than 2 percent) corn flour was prepared (see Appendix B.) The estimate used a corn price of S/280/qq; milling costs of S/73/qq of corn flour produced based on wheat milling experience; production of 70 percent corn flour, 22 percent hulls-meal animal feed selling at S/200/qq and 8 percent corn germ selling at S/420/qq and a profit of S/20 per qq of corn flour produced.

In summary, corn production has been erratic, but, as indicated in 1980, price sensitive. Evidently, production can be increased with appropriate incentives. Production projections by MAG, National Seed Program, suggest a close balance between supply and demand. A new 24,000 MT net corn demand for composite flours would require further corn production incentives. Corn flour production, in Ecuador, may be initiated at Oleica in 1981 with substantial capacity. Such a development is of substantial significance for the composite flour program.

Some Economic Aspects of the 87-10-3 Composite Flour:

Table 6 gives the National production, imports and subsidies for wheat. Imports have increased rapidly while National production has declined.

Prices of wheat on the International market have moved up sharply in 1980 and CIF wheat with 90 days financing costs $US 237/MT at Guayaquil (November 1980.) This is $US 100/MT (S/114/qq) over the GOE reference price of $US 137.74/MT, the price that wheat millers pay for wheat. The GOE pays the difference as a subsidy. Since 133 lbs. of wheat are necessary to produce 1 qq of wheat flour, the subsidy on a wheat flour basis is (1.33) (S/114/qq) = S/152/qq of wheat flour.

Appendix D

TABLE 6

Wheat Production, Imports and Subsidies [a/]

Year	Production[b/] qq x 1000	Subsidy for National Wheat S/qq	Imported qq x 1000	Subsidy for Imported Wheat S/qq
1973-74	632	30	2,889	113
1974-75	652	50	3,452	133
1975-76	587	50	4,976	69
1976-77	513	50	5,026	41
1977-78	504	50	5,236	51
1978-79	496	50	5,853	18

Source: Navarrete, H. et al. "Estudio sobre la Comercializacion del Trigo y Productos Derivados". MAG. PNUD/FAO - ECU/78/007, July, 1980.

a/ 1.33 qq of wheat are required to produce 1 qq flour.

b/ Does not include seed or on farm consumption, includes only that sold to mills.

Appendix D

In August of 1980, to meet rising flour manufacturing costs, the GOE instituted a new flour subsidy of S/33/qq for the Coast and S/42/qq for the Sierra. With these added costs, the GOE total subsidy for wheat flour per qq is currently S/152 + S/33 = S/185 for the Coast and S/152 + S/42 = S/194/qq of flour for the Sierra. The average flour subsidy for the country then is about S/190/qq.

The fixed price for wheat flour is S/253/qq, thus the true cost of flour from imported wheat is S/253 + S/190 = S/443/qq. At this price, soy and corn flour are substantially more competitive for substitution into wheat flour (composite flour).

Another way to look at the situation is to calculate what the price of soy or corn flour would be if subsidized at the wheat flour rate of S/190/qq. Figure 2 shows the cost that composite flour would be if the subsidy on substituted wheat flour was used to subsidize the corn and soy flours. As seen in Figure 2, the composite flour is competitively priced with wheat flour (S/253) when the subsidy reaches a level of S/200/qq on the Coast and S/215/qq in the Sierra.

At 13 percent substitution, as proposed by the Escuela Politecnica Nacional, Ecuador would be able to reduce the imported wheat requirement by 41,600 MT in 1981. The foreign exchange savings (assuming the wheat millfeed reduction of 10,400 MT could be made up domestically) would be 41,600 MT x $US273 = $US 11,356,800. The GOE subsidy on 41,600 MT of wheat (November 1980 prices) would be $US 5,216,640 which might be used to subsidize soy and corn flour substituted for the wheat flour.

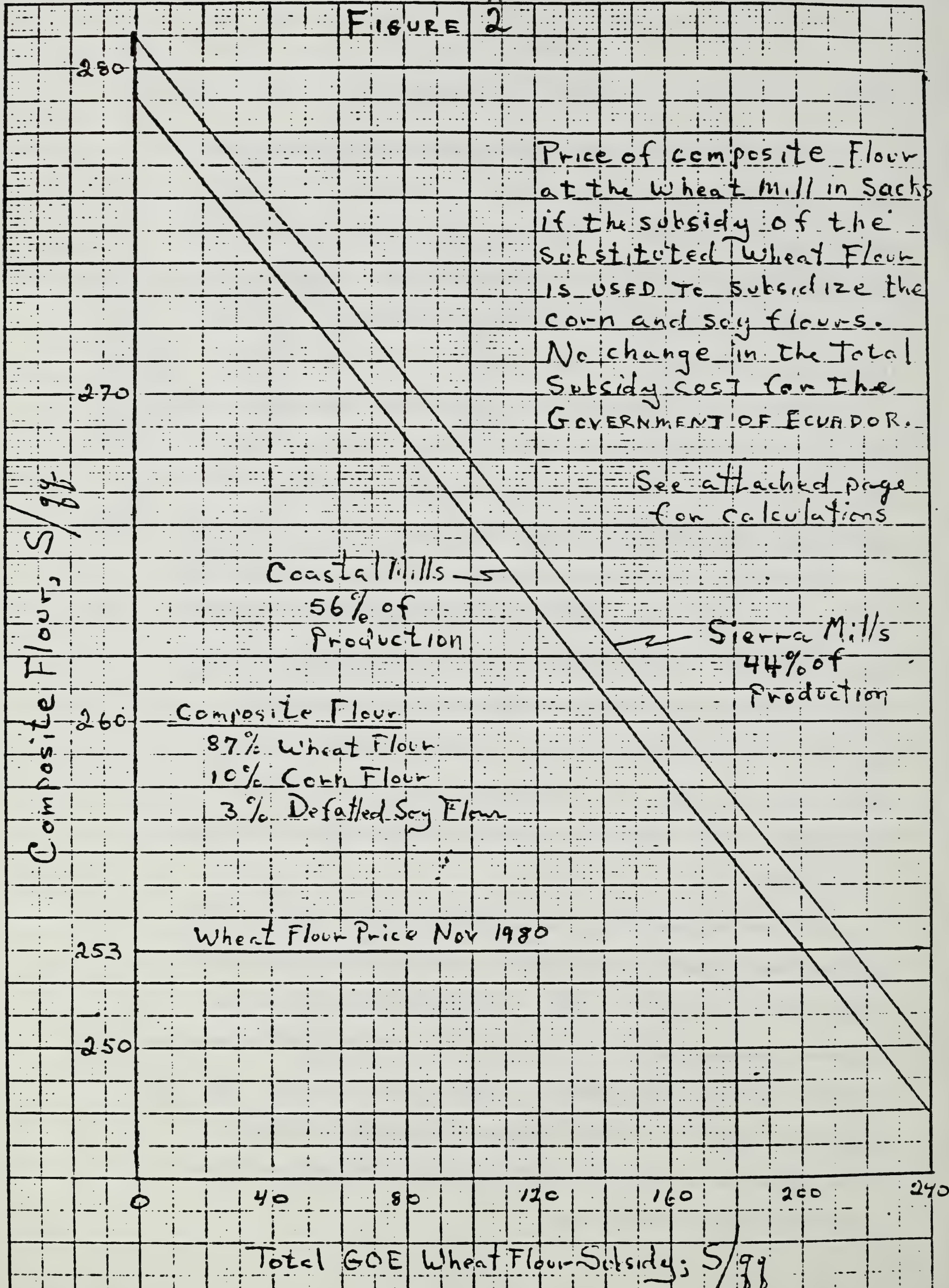


FIGURE 2
Price of composite Flour at the Wheat Mill in Sacks if the subsidy of the Substituted Wheat Flour is used to subsidize the corn and soy flours. No change in the Total Subsidy cost for the Government of Ecuador.
See attached page for calculations
Coastal Mills 56% of Production
Sierra Mills 44% of Production
Composite Flour
87% Wheat Flour
10% Corn Flour
3% Defatted Soy Flour
Wheat Flour Price Nov 1980
280
270
260
253
250
0
40
80
120
160
200
240
Composite Flour, S/qq
Total GOE Wheat Flour Subsidy; S/qq

Explanation of Figure 2

Equation:

1. $$S/_{qq}HC = (0.87)(S/_{qq}HT) + (0.10)(S/_{qq}HM - S/_{qq}HT\,Subsidy) + (0.03)(S/HS - S/_{qq}HT\,Subsidy) + M_x + R_{HC}$$

Where: S/ = Sucres; 25 Sucres = $1.00 (official)
HC = Harina Compuesta
HT = Harina de Trigo
HM = Harina de Maize
HS = Harina de Soya sin grasa
M_x = Millers fee for blending Composite flour per qq = S/2.0
R_{HC} = Millers profit on handling 13 % of non-wheat flours = (S/20)(13%) = S/2.6 per qq of HC. Note: Profit for wheat milling, corn milling and soy processing are included in the prices for those flours

Prices used in Calculations:

Item	COASTAL	SIERRA
Wheat Flour, S/qq	253.00	253.00
Corn Flour, S/qq (in sacks)	391.84	391.84
Transport to wheat Mill, S/qq	5.00	16.00
Storage at Wheat Mill, S/qq	1.50	1.50
Total Corn flour Cost at Wheat Mill	398.34	409.34
Soyflour, defatted S/qq (in sacks)	484.41	484.41
Transport to Wheat mill, S/qq	5.00	16.00
Storage at Wheat Mill, S/qq	1.50	1.50
Total Soy Flour Cost at Wheat Mill	490.91	501.91

Alternative Ideas for Implementation:

It is obvious that composite flours will not occur voluntarily under current conditions because the prices or potential prices of corn and soy flours are higher than wheat flour; the miller/baker/pasta manufacturer would be increasing his ingredient costs with no increase in selling price. However, observations in Latin America have shown that when quality, non-wheat flours are available at a lower cost than wheat flours, the wheat flours are often extended with such non-wheat flours in order to improve profitability and competitiveness.

Since production of corn, soy and rice crops are already marginal with respect to meeting demand in Ecuador, lower prices for the flours of these cereals are not likely. An alternative is to raise the price of wheat flour sufficiently so that corn flour and soy flour would be less expensive. If this were done and enabling legislation for composite flours enacted, then some composite flours might be utilized on a voluntary, self-initiative basis. However, it seems unlikely that the price of wheat flour would be increased to the area of S/500 per qq that would make such an option attractive.

Another approach to a voluntary program would be for the GOE to subsidize corn flour and soy flour at a price below wheat flour (below S/253 per qq). The subsidized price below wheat flour would be offered to either wheat millers or bakers (not both) who, if they purchased it, would be obligated to use it only for composite flours. It is doubtful if such a program would provide sufficient incentive for soy and corn processors to invest and install the necessary processing equipment to produce the needed

soy and corn flours because the demand would be very difficult to gauge.

Summing up, it does not appear that voluntary programs have much chance of success.

Mandatory programs are the only ones that seem to suggest substantial implementation of composite flours. There appears to be 4 basic options with variations possible within each.

Non-subsidized:

1. pasta only
2. pasta and baked goods

Subsidized:

1. pasta only
2. pasta and baked goods

Any mandatory program would create a specific market demand for soy and corn flours thus providing a strong incentive for industrial investment to produce them.

The non-subsidized/pasta and baked goods option and the subsidized/pasta and baked goods option are similar to the Escuela Politecnica Nacional proposal that has already been discussed.

Non-subsidized/pasta only. Pasta represents about 20 percent of the wheat flour market in Ecuador. Up to 30 percent partially pregelatinized corn flour and 10 percent of fully toasted, defatted soy flour can be substituted for wheat flour. Experience in Colombia[8/] has demonstrated the success of corn-soy-wheat pastas. A 40 percent substitution in pastas would reduce the 1981 wheat import requirement by 19,200 MT with an annual foreign exchange savings of $US 5,241,600 when C.I.F. wheat is $273/MT. In addition, the GOE would save $US 3,210,240 in subsidies when

the wheat flour subsidy is at S/190 per qq. The retail price of pastas would need to be increased. For example, if pastas in bulk currently sell at S/506 per qq the higher ingredient costs for corn flour (S/392 per qq) and soy flour (S/484 per qq) would require a new retail pasta price of S/570.9 per qq. This would be a 12.8 percent increase in the pasta price. (This simple calculation does not include any costs for transportation or incentive fees for the pasta manufacturer.

Blending of the corn/soy/wheat could be done by the pasta manufacturers of which there are relatively few. Therefore, regulation would be greatly simplified. The pasta manufacturer would need little or no additional equipment. Such an option seems an excellent way to initiate a composite flour program and obtain experience before moving ahead to the more difficult program of composite flours for bread. For initial implementation, the substitution level for pastas might be at a reduced rate to insure that start up supplies of corn and soy flours are adequate. As the quantity and quality of corn and soy flours available increase, the substitution level in pasta could be increased.

Close GOE control would be needed to insure the pasta manufacturers incorporated the more expensive corn and soy flours.

Subsidized/pasta only. In this option, the GOE would still have the $US 5,241,600 savings in foreign exchange because of reduced wheat imports but instead of a reduction of $US 3,210,240 in wheat subsidy

costs, the reduction would only be $US 189,236 if the price of pasta was not to change. Because wheat, corn and soy flours would all be the same price to the pasta manufacturer, there is no financial or profit advantage in shifting the composition of the specified composite flour thus adherence is more likely than under the non-subsidized situation.

Conclusions:

While nutritional data and political guidelines are largely missing from the composite flour data base, substantial information on technical feasibility, acceptability, costs, potential economic gains and so forth have been accumulated. To obtain the nutritional data (nutrients and wheat flour consumption data by various groups and relationship to malnutrition) necessary to recommend the composition of a composite flour from a nutrition intervention point of view, would take a very substantial program. On the other hand, composite flours may be justifiable on their economic merits alone and the information necessary for justification (foreign exchange savings, stimulation of demand for domestic agricultural products, effect on subsidies, etc.) is readily available.

It is my belief the next step should be to establish a middle level task force free from other duties that would:

1. Obtain political guidance, e.g. on subsidies crop production incentives, etc.
2. Review options as to advantages and disadvantages.
3. Select an option and prepare a specific composite flour implementation plan.

4. Submit the plan for review and comment by industry and others; modify as necessary.

5. Submit the plan to the appropriate high level GOE decision board and be prepared to support.

Such a plan would need to provide for:

1. Wheat products to be affected; pasta only? Others?

2. Start up composition of the composite flour and final composition. Include composite flour specifications.

3. Pricing to include any subsidies and a pricing and subsidy review system.

4. Procedure for start up (by region? nationally?) and progression to total implementation.

5. Agricultural production of corn and soy to meet new demands.

6. Source(s) of corn flour and soy flour. Includes specifications of products, quantities required and quotas of raw agricultural commodities to insure production goals. Consider inventory requirements for start up and operation of the program.

7. Quality assurance and regulation.

8. Coordination with wheat import program and quota system of wheat to mills and wheat flour users.

9. Financial plan.

10. Proposed enabling legislation or decree.

11. Chronogram.

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(APPENDIX A)

Partial List of Reports Prepared by the Instituto Investigaciones Tecnologicas, Escuela Politecnica Nacional at Quito and Cooperating Institutes on Composite Flours. Support Provided by the Ministry of Agriculture

1. Final Report on Composite Flours. IIT/EPN 1979.

   Chapter 1. Recommendations and Conclusions; Description of the Project; Summary of the Results.

   Chapter 2. Investigations at the Laboratory Level.

   Chapter 3. Market Study of Wheat Flour and Bread.

   Chapter 4. Economic Consideration.

   Chapter 5. Studies in a Pilot Bakery.

   Chapter 6. Acceptence Studies of Composite Flour Breads.

2. Study of Production and Acceptability of Composite Flour Breads and Pasta at a Military Installation in Quito. IIT/EPN 1980. (Includes a manual, Bread Making for Masters and Operators.)

3. Soy Flour for Human Consumption. IIT/EPN 1980. (Includes statistics on soy production, production costs, cost estimates for soy flour production.)

4. Acceptability of Composite Flour Breads at the Commercial Level. Datos Ecuador (Contract from IIT/EPN) 1980.

5. Economic Analysis for the Production of Composite Flours in Ecuador. Ecuadorian Center for Industrial Development (CENDES), Ministry of Industry, April 1980.

6. Utility of Potatoes for Composite Flours. IIT/EPN mid 1970's.

7. Utility of Yuca (Cassava) for Composite Flours. IIT/EPN mid 1970's.

Other Pertinent Documents

8. Market for Oilseeds and Their Products. Project PNUD/FAO; ECU/78/007. Ministry of Agriculture, October 1980.

9. Analysis of the Rice Market in Ecuador. Project PNUD/FAO; ECU/78/007. Ministry of Agriculture, November 1980.

(APPENDIX A (cont'd))

10. Analysis of the Corn Market. Project PNUD/FAO; ECU/78/007. Ministry of Agriculture, November 1980.

11. Studies on the Marketing of Wheat and its products. Project PNUD/FAO; ECU/78/007. Ministry of Agriculture, July 1980.

Appendix D

FSAS/TF/ECU/053/MUL
Informe Técnico

PLAN DE ASISTENCIA PARA
LA SEGURIDAD ALIMENTARIA

ECUADOR

EVALUACION DEL PROGRAMA
DE HARINAS COMPUESTAS DEL ECUADOR

Informe preparado para
el Gobierno del Ecuador
por
la Organización de las Naciones Unidas
para la Agricultura y la Alimentación

basado en el trabajo de
J. Faure
Experto del Departamento de Servicios de Industrias
Alimentarias y Agrícolas

ORGANIZACION DE LAS NACIONES UNIDAS
PARA LA AGRICULTURA Y LA ALIMENTACION FAO

Quito, Noviembre 1980

Appendix D

Borrador Reservado
FSAS/TF/ECU/053/MUL
Informe Técnico

(Appendix B).

PLAN DE ASISTENCIA PARA LA SEGURIDAD ALIMENTARIA

ECUADOR

EVALUACION DEL PROGRAMA DE HARINAS COMPUESTAS

ORGANIZACION DE LAS NACIONES UNIDAS
PARA LA AGRICULTURA Y LA ALIMENTACION FAO

QUITO, NOVIEMBRE 1980

FSAS/TF/ECU/053/MUL INFORME TECNICO ECUADOR PLAN DE ASISTENCIA PARA LA SEGURIDAD ALIMENTARIA

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INTRODUCCION

Las importaciones de trigo han venido incrementándose rápidamente en el Ecuador. En efecto, de un promedio equivalente a 60.000 TM al final de la década de los años 60, se ha pasado a 300.000 TM en 1980. Estas importaciones representan ahora más del 95% del consumo nacional de trigo.

En 1972, el Gobierno implementó un programa de investigación en la Escuela Politécnica Nacional, con el fin de estudiar las posibilidades técnicas de reemplazar parte de la harina de trigo por otros productos disponibles en el país.

En 1978 se llevó a cabo una misión de consultoría, a cargo del señor P. Sluimer, Experto de FAO en cereales y panificación, dentro de la estructura del Plan de Asistencia para la Seguridad Alimentaria, para identificar la fórmula más apropiada para harinas compuestas y asistir en la preparación de un programa para una planta piloto para ensayos y pruebas de producción de pan con harinas compuestas.

Desde entonces se han logrado significativos avances, gracias al esfuerzo desplegado por la Escuela Politécnica Nacional, el Ministerio de Agricultura y Ganadería y el Programa Nacional de Seguridad Alimentaria, con la asistencia de FAO.

La presente misión fue requerida por el Gobierno y financiada por el Proyecto de Seguridad Alimentaria FSAS/TF/ECU/053/MUL. La misión estuvo en el país del 20 de Octubre al 14 de Noviembre de 1980 y trabajó con la Escuela Politécnica Nacional y los Departamentos de Agroindustrias y de Seguridad Alimentaria del MAG, los cuales amablemente proveyeron toda la asistencia que fue solicitada.

Los términos de referencia de la misión fueron discutidos al inicio de la consultoría con el Ministerio de Agricultura y la Escuela Politécnica Nacional y se concretó de la siguiente forma:

1. Evaluar el progreso de las investigaciones y resultados alcanzados por la Escuela Politécnica Nacional en el campo de las Harinas Compuestas, y en particular:

   a) La selección de una fórmula apropiada de harinas compuestas por la Politécnica.

   b) Los ensayos de la planta piloto y las pruebas de aceptabilidad para la producción de pan y pastas.

2. Hacer recomendaciones acerca de futuras investigaciones que fueren necesarias.

3. Examinar las implicaciones económicas de producir harina compuesta a nivel nacional y establecer líneas de acción en la preparación del estudio de factibilidad de harinas compuestas en el Ecuador.

4. Asesorar en el manejo y operación de un Programa Nacional de Harinas Compuestas así como las recomendaciones para su implementación.

CONCLUSIONES Y RECOMENDACIONES

1. Sólo pequeños trabajos adicionales se requieren en los aspectos de investigación:

    a) Realizar una prueba de aceptabilidad en Guayaquil, con pan y fideos de varios tipos.

    b) Producir galletas y probar la aceptación en Quito o Guayaquil.

    c) Probar el uso de la harina de maíz precocida que producirá la Empresa OLEICA en 1981 para la panificación y fidelería.

    d) Entrenar al personal técnico en el análisis de harina compuesta y estudiar un método para controlar el porcentaje de incorporación de maíz y soya. Comprar el equipo de laboratorio necesario.

2. El principal problema para la producción de harina compuesta en el país es la disponibilidad de maíz y soya. La cantidad requerida no está disponible al momento. Estadísticas de producción y una evaluación del futuro abastecimiento no son satisfactorios. La relación de precios oficiales entre el trigo y otros cereales producidos en el Ecuador hace a la harina compuesta más cara que la harina de trigo y favorece la importación de trigo, en lugar de favorecer la producción nacional. Sin embargo, considerando el sistema de subsidio actual y a los últimos precios internacionales del trigo, la producción de harinas compuestas es más rentable que la producción de harina de trigo.

    Para permitir al Gobierno tomar una decisión en lo que se refiere a la implementación del Programa de Harinas Compuestas a nivel nacional, los estudios a ser realizados lo más pronto posible han sido descritos en el Capítulo II. Esta lista comprende lo siguiente:

    a) Un estudio para fomentar el desarrollo de la producción de trigo y maíz en el Ecuador.

    b) Un estudio de factibilidad para la producción de harina de maíz y harinas compuestas bajo las distintas alternativas.

    c) Estudio del subsidio a ser aplicado en caso de producir harinas compuestas en el Ecuador.

    Todos estos estudios deberán ser de responsabilidad del MAG con la colaboración de las otras instituciones y deberán ser presentados a la Comisión recomendada en el Capítulo II.

3. Para asistir al Gobierno en estos aspectos, se propone que se contacte alguna agencia de desarrollo internacional para disponer de lo siguiente:

    a) Un Economista especializado en Agroindustrias para revisar el estudio de factibilidad preparado por el MAG antes de la finalización y presentación a la Comisión de Harinas Compuestas. (Un mes, en Marzo de 1981.)

b) Un Experto en procesamiento de maíz para evaluar las disponibilidades y equipos existentes en la industria molinera y las inversiones requeridas para la instalación de un nuevo molino de maíz y las inversiones necesarias en los molinos de trigo existentes, para la producción de harinas compuestas. (Un mes, en Febrero de 1981).

c) Una beca de 3 meses para entrenamiento en el extranjero, en análisis de mezclas de varias harinas para un técnico especialista en química de cereales de la Escuela Politécnica Nacional. Posiblemente en los Estados Unidos o Europa.

d) La compra de aparatos de laboratorio para la Escuela Politécnica, como por ejemplo, equipo electro-forese y un equipo de cromatografía.

4. Se recomienda además que las reuniones periódicas del Comité de Trabajo de Harinas Compuestas que se venían sosteniendo a iniciativa de la Dirección de Planeamiento de la Seguridad del MAG, y que se dejaron de lado por parte de la Unidad Ejecutora, Departamento de Agroindustrias, se inicien nuevamente para que todas las instituciones colaboren coordinadamente en la realización de este proyecto.

CAPITULO I

EVALUACION DEL TRABAJO DE INVESTIGACION Y PROGRAMA DE DESARROLLO DEL PROYECTO DE HARINAS COMPUESTAS REALIZADO EN LA ESCUELA POLITECNICA NACIONAL, INSTITUTO DE INVESTIGACIONES TECNOLOGICAS

I. Fase de Laboratorio.-

Descripción.-

Las investigaciones a nivel de laboratorio fueron iniciadas en 1973, habiendo progresado considerablemente hasta 1978, experimentándose con diferentes clases de mezclas: papa (1974), yuca (1974), maíz (1976), soya (1977), arroz (1977) y quinua (1978) siendo convertidos en harina o almidón y mezclados con harina de trigo, en varias proporciones, para la producción de pan, considerando también distintas variedades de yuca, papas y maíz. Se produjo pan de diferentes tipos y pesos, que luego fue comparado con el pan hecho con 100% de harina de trigo y horneado de manera tradicional en el Ecuador. Todos los experimentos estuvieron controlados mediante análisis químico/físicos, tanto de la materia prima y los materiales, como del producto final. La calidad del pan fue controlada por los expertos del Instituto.

El resultado de este programa de investigación de 6 años fue la elección de una fórmula que incluye 90% de harina de trigo producida por los molinos ecuatorianos, con 10% de harina de maíz. Harina de arroz puede ser considerada también al mismo nivel de 10% de incorporación. Alternativamente, la posibilidad de una mezcla de 3 componentes fue escogida, mezclando 87% de harina de trigo, con 10% de harina de maíz y 3% de harina de soya para suplementar el nivel nutritivo del pan.

La harina de maíz fue obtenida de una variedad local de maíz amarillo, duro, con bajo contenido de grasa (menos del 2%) que fue preferida para el horneo. La harina de trigo fue obtenida de trigo importado, mezclado con trigo nacional en varias proporciones, dependiendo de la disponibilidad del producto en el Ecuador. Sin embargo, el trigo importado fue el mayor componente empleado, alcanzando por lo menos 70% y hasta el 100%. Con las harinas compuestas elegidas se usa el procedimiento tradicional de horneo, sin necesidad de ingredientes de mejoramiento de la masa.

Más tarde, en 1979, la mezcla de maíz y trigo fue usada para la producción de pasta, a nivel de laboratorio, la cual fue totalmente aceptada.

Comentarios.-

1) Esta investigación a gran escala fue necesaria para definir las posibilidades técnicas de procesar productos agrícolas locales para la elaboración de harina y poder sustituir en forma parcial al trigo importado. Este trabajo fue conducido en secuencias lógicas. Dió al personal técnico de la EPN la oportunidad de familiarizarse con la tecnología de las harinas compuestas, con el trabajo llevado a cabo en otros países de Latinoamérica y otros en el mismo campo, y el personal tuvo la oportunidad de aplicar sus conocimientos a productos y condiciones predominantes en el Ecuador.

2) Las conclusiones de la EPN no son sorprendentes. La incorporación de carbohidratos, a más del trigo, no afecta la calidad del pan, cuando se limita a un 10% en harina, especialmente cuando se usa trigo de alto contenido proteico (12%). Una mezcla más alta cambiará significativamente la apariencia, el sabor y la tecnología del horneo.

la absorción de agua de la harina compuesta, comparada con la harina de trigo, se aumenta del 1% al 5%, dependiendo de la fórmula. Esto ha sido confirmado por investigaciones realizadas en otras partes. Esto no modifica el procedimiento para la producción de la masa.

3) La alternativa de producir un tipo completamente diferente de pan, no fue considerada en el programa. Empleando de un 30% a un 50% de maíz o almidón y de un 70% a un 50% de harina de trigo, se puede producir pan, ya sea de color amarillento (maíz) o blanco (almidón), con un volumen limitado por el mismo peso, comparado con el uso de 100% de harina de trigo. Además, considerando aspectos económicos y nutricionales, este tipo de pan absorberá solamente una pequeña parte del mercado y la importación de trigo no sería afectada en lo más mínimo. La EPN, por lo tanto, tuvo razón en considerar una fórmula que podría ser utilizada para todos los tipos de pan existentes en el Ecuador.

4) La incorporación de un 3% de harina de soya, preferiblemente desgrasada, dará un contenido proteico de 1% o 2% más alto que el pan existente en el mercado actualmente, dependiendo también del contenido proteico de la harina de maíz, el cual es de 8.5% promedio. Por lo tanto, un aumento del valor nutritivo será limitado. Un porcentaje de incorporación más elevado será considerado hasta un 6%, si es económicamente factible, pero esto reducirá un tanto el volumen y la aceptabilidad del pan. Esto puede considerarse una vez que la fórmula con 3% de soya sea implementada y aceptada a escala nacional.

5) En cuanto a la elección de maíz en vez de otro cereal o almidón, un factor positivo adicional es el de que se puede organizar más fácilmente el abastecimiento, considerando los aspectos económicos y técnicos del país. Por lo tanto, esta elección ha sido apoyada.

6) Durante la fase de laboratorio, la producción local de trigo disminuyó rápidamente de 68.000 TM en 1971/72 a 20.000 TM en 1978/79, mientras que las importaciones de trigo aumentaron anualmente en un 13%, alcanzando las 264.000 TM en 1979. Esto se debe a varias razones, particularmente a que el trigo local estuvo considerado menos remunerativo que cosechas de otros cereales (ver anexo 1), por la falta de una política gubernamental dinámica para apoyar la producción local. Por tanto, se hizo imprescindible la busca de una fórmula alternativa de harinas compuestas y la fase piloto fue finalmente implementada en 1978 - 1979.

I. Fase Piloto.

Descripción.-

Esta fase incluye:

- El reclutamiento de 3 técnicos instructores en la tecnología de harinas compuestas para la producción de pan y su entrenamiento teórico/práctico de 10 semanas. Uno de ellos permanece aún en la EPN. Los otros dos se han incorporado a panaderías privadas, lo que se considera conveniente para la fase piloto del programa en el país.

- La producción de todo tipo de pan y pasta en la planta piloto de la EPN, con los mencionados instructores.

- La producción de pan en las panaderías del Ejército, en Quito, con un total de 60 toneladas de harinas compuestas.

- La producción de pan y "cachos" en 3 panaderías comerciales de Quito, con un total de 140 toneladas de harinas compuestas.

- Entrenamiento de 20 panaderos del Ejército.

- Aceptación de los consumidores, mediante una encuesta llevada a cabo por una compañía especializada en Quito, sobre una muestra representativa de la población.

- La producción de 2.200 Kg. de pasta (tipo spaghetti) con dos fórmulas distintas, por una firma comercial, usando el método de extrusión.

- Pruebas de aceptación de las dos fórmulas arriba mencionadas, llevadas a cabo, al igual que el pan, con 400 familias de Quito.

- La aceptación del pan y pasta por varias instituciones y por el Ejército.

Debe anotarse que en 1976 ya se condujo una encuesta con la industria molinera de trigo en el Ecuador, la misma que llevó a cabo el Ministerio de Agricultura y otra encuesta se realizó en Quito, Guayaquil, Ambato, Portoviejo e Ibarra, por medio de la EPN, relativa a la capacidad y equipo de las panaderías. Además se hizo una encuesta en Quito sobre los requerimientos de pan y hábitos de compra del consumidor.

Comentarios.-

1) Generales: Fue una fase muy completa, la cual confirmó los resultados de laboratorio y la aceptación de los productos por los panaderos y consumidores.

2) Materia prima: En la fase piloto, grandes cantidades de materia prima fueron requeridas, y el Instituto tuvo problemas en obtener harina de maíz con 2% de grasa, recomendada por los estudios de laboratorio. El único molino de maíz en el Ecuador está localizado en Latacunga, a 100 Km. de Quito y está equipado para moler granos con aproximadamente 6% de grasa, para la industria cervecera. La harina que se obtiene remoliendo estos granos no puede almacenarse adecuadamente y el programa nacional, definitivamente debe conservar como requerimiento el 2% de grasa.

3) Panificación: Las panaderías de Quito y la planta productora de pasta estuvieron listas a colaborar. Se notó que las panaderías no tuvieron dificultad en emplear la harina compuesta usando su propio equipo. En particular, algunas de éstas ya producen "pan integral", mezclando directamente en la mezcladora de masa, harina de trigo con hasta un 20% de afrecho entregado por los molinos.

   El horneo se hizo en Quito solamente y las características organolépticas fueron similares a los resultados del laboratorio. Se recomienda organizar pruebas de panificación durante 3 días en una panadería de Guayaquil para controlar la influencia de cambios significativos en las condiciones climáticas entre la Costa y la Sierra y en los procedimientos de horneo, para evitar problemas de última hora.

4) Molienda: La encuesta a nivel de los molinos, realizada en 1976, indica que 3 molinos han producido harina de maíz en el pasado y 13 de los 20 molinos establecidos en el Ecuador dicen estar interesados en moler maíz. Esto habla en favor del programa, usando maíz en lugar de arroz.

5) Interés: Siempre que el margen de utilidades se mantenga, los panaderos y molineros, en su mayoría, demuestran interés en este proceso. Esto es ponderable, ya que en otros países como en Africa, la primera reacción a las harinas compuestas fue negativa. Sería conveniente chequear estos resultados otra vez, pues la encuesta data de 1976.

6) Pruebas de Aceptación: Las pruebas de aceptación del consumidor, merecen tres consideraciones:

   a) Pan y pasta fueron aceptados y apreciados.

   b) Hay la opinión de que el pan comprado en el local de la panadería o en las distribuidoras contiene maíz.

   c) El paso lógico a tomarse luego de una encuesta favorable con el consumidor, es la encuesta sobre mercadeo, a escala de ciudad o de provincia, como para cualquier producto a ser introducido en el mercado. Sin embargo, el propósito de este Programa de Harinas Compuestas, no es el de introducir un nuevo producto para competir con el tradicional. Es mas, éste debería ser lo más parecido posible al existente. Además hay que considerar que es muy difícil o imposible organizar la distribución de harina compuesta a las panaderías de una ciudad o provincia, ya que se proveen de 2 o 3 molinos diferentes.

7) Galletas.- El consumo de harina de trigo es como sigue: 62% para pan, 20% para fideos, 5% para galletas y 13% para "propósitos no identificados". Sería práctico considerar que todos estos productos deben ser hechos con la misma fórmula de harina compuesta. Por lo tanto, se recomienda que la EPN y una empresa comercial colaboren en la prepración de galletas y realicen una encuesta de aceptación en Guayaquil y Quito, o por lo menos en una de estas ciudades, para evitar problemas de última hora.

8) Pasta.- En cuanto a las pruebas de aceptación de pasta (fideos) se ha notado que solo se produce pasta tipo spaghetti procesado por extrusión, mientras que las fábricas locales usan el procedimiento de "laminado" que da un producto más blanco. Esto puede explicar la pequeña diferencia - no estadísticamente representativa - demostrada en las encuestas realizadas en Quito de aceptación por el consumidor.

III. Conclusiones y Recomendaciones.-

Los logros de la EPN/IIT en los últimos 2 años son significantes y la elección de la fórmula de harina compuesta, la cual es plenamente apoyada como la mejor elección, tanto técnicamente como de aceptabilidad por la industria molinera, las panaderías y el consumidor es adecuada. Además el maíz es probablemente el producto sustitutivo menos costoso al momento en el Ecuador. Una mezcla de maíz y trigo es más simple y más económica que una mezcla de 3 componentes como maíz/trigo/soya. Sin embargo, la adición de soya debe tenerse en cuenta para mejorar el contenido proteico del pan para balancear la baja calidad de horneo de la harina de maíz. La adición de 3% de soya para compensar la deficiencia en proteína de la harina de maíz aumentará en realidad el contenido proteico de la harina compuesta solamente en un 0.5% al 1%. Sin embargo, esto dará una composición aminoácida más balanceada, suplementando la deficiencia de lisina en el maíz y el trigo.(Anexo 2

Si no se dispone de harina de soya (desgrasada), o es muy costosa al momento de

empezar la producción de harina de maíz a nivel nacional, solamente debería introducirse en el mercado harinas compuestas conformadas por la harina de trigo y de maíz. El 3% de harina de soya puede ser incorporado uno o dos años más tarde, cuando haya disponible.

Las investigaciones adicionales en lo referente a la parte técnica de producción de harinas compuestas, actualmente no es prioritario. No hay necesidad de mejorar la fórmula, o el procedimiento de horneo o de molienda. Se sugiere solamente hacer una prueba de horneo en Guayaquil y producir galletas para una prueba de aceptación en Quito o Guayaquil.

Debería comenzarse, en cuanto llegue el farinógrafo ordenado por la EPN/IIT, un análisis de rutina de la harina de trigo de todos los molinos de la Sierra y en la ESPOL para los molinos de la Costa. Además deberían probarse los métodos de laboratorio para detectar y controlar el porcentaje de maíz y posiblemente de soya incorporados. Debe contactarse para esto al Dr. Lars Munch, Carlsberg Research Laboratory, Carlsbergweg, Copenhague, Denmark; y a M.J.C. Miche, Laboratoire des Cereales, INRA 9 Place Viala - Montpellier 34060, France y otros institutos de investigación.
El principal problema y lo prioritario debe ser la posibilidad económica de producir e introducir en el mercado una harina de trigo/maíz/soya a escala nacional. Muchas son las implicaciones y se necesita de la decisión gubernamental y del apoyo de los Ministerios de Finanzas, Agricultura e Industrias. Bajo nuestro punto de vista, lo que implica en el Ecuador un Programa de Harinas Compuestas, consta en la segunda parte de este informe.

CAPITULO II

PROBLEMAS Y RECOMENDACIONES PARA EL ESTUDIO DE FACTIBILIDAD DE INTRODUCCION DE HARINAS COMPUESTAS A NIVEL NACIONAL

El estudio de factibilidad deberá analizar en detalle todos los factores que inciden para un Programa Nacional de Harinas Compuestas y las decisiones que deberán tomarse a nivel gubernamental en base a las distintas alternativas consideradas.

Los factores son los siguientes:

1. Existe suficiente producción de maíz y de soya en el Ecuador para abastecer un Programa Nacional de Harinas Compuestas? Si nó, cuándo? y qué deberá de hacerse para incrementar esta producción? No será más factible (más fácil técnicamente y a menor costo) el incrementar la producción local de trigo o de otros granos alternativos, como sorgo para reemplazar al maíz en alimentos balanceados para consumo animal y así disponer de maíz para el Programa? Estará el arrocillo más fácilmente disponible?

2. Cuál es el costo de producir Harinas Compuestas? A qué precio de venta de la harina es factible económicamente la instalación de un molino de maíz y para qué capacidad? Dónde deberá localizarse el molino de maíz? Qué organismo deberá financiar y operar el molino? Cuál es el sistema más adecuado de producción y distribución de harinas compuestas de los molinos a las panaderías?

3. Deberán las Harinas Compuestas beneficiarse de un subsidio como es el caso del trigo importado para hacerlo competitivo? Cuál sería el monto de este subsidio en el sistema presente? Será menor que el de trigo?

4. Quién deberá realizar el estudio de factibilidad? Cuál es el cuadro institucional requerido para organizar y controlar la implementación de un Programa Nacional?

Estos cuatro puntos son necesariamente discutidos más adelante y servirán de guía para el estudio de factibilidad. Recomendaciones y cálculos preliminares han sido realizados cuando ha sido necesario.

1. Disponibilidad de materia prima.-

   El consumo de trigo en el Ecuador se estima en aproximadamente 300.000 TM para 1980/81. Por lo tanto, una Harina Compuesta con 10% de harina de maíz reduciría la importación de trigo en unas 30.000 TM, que serán sustituídas por unas 32.000 TM de maíz. 1/ Esta cantidad representa aproximadamente el 20% de la producción nacional de maíz. De igual manera, sustituyendo el 3% de harina de trigo por harina desgrasada de soya, se necesitaría más o menos 7.500 toneladas de harina de soya, o 13.000 toneladas de soya en grano. 2/. Esto representa un 42% de producción nacional de soya en 1979. En este caso se reduciría adicionalmente 9.000 TM de trigo importado.

   a) Las cantidades adicionales de maíz y soya requeridas para el Programa Nacional de Harinas Compuestas no puede ser satisfecho por el mercado nacional, sin causar una conmoción.

1/ Asumiendo una tasa de 70% de extracción para obtener una harina de maíz de menos de 2% de grasa. La tasa de extracción para trigo es de 75%.

2/ Asumiendo el factor técnico de conversión de 100 Kg. de grano por 58 Kg. de harina desgrasada.

El Ecuador prácticamente se autoabastece de maíz, pero nó lo suficiente para acarrear existencias de año en año. De vez en cuando se importan hasta 15.000 toneladas de maíz, cuando hay una mala cosecha. En cuanto a la soya, la producción se está expandiendo rápidamente debido al precio atractivo para el agricultor y la alta demanda de aceite de mesa y torta Llevará algunos años antes de que el mercado pueda ser autoabastecido y parte de esta soya pueda convertirse en harina para consumo humano. 1/

b) Por lo tanto, el Programa de Harinas Compuestas dependerá enteramente de la posibilidad de incrementar el cultivo de maíz en unas 30.000 Has. y la producción de soya en 10.000 Has. La política del Gobierno está encaminada hacia estas metas.

El país podría y debería producir más maíz para obtener una ganancia, con o sin este Programa. Las medidas a tomarse para promover el cultivo de maíz, como: incentivos de precios, facilidades de crédito, mejoramiento de las semillas, etc, son conocidas. Se recomienda que los costos de estos programas sean calculados por el MAG, pero esto está fuera del alcance del presente estudio de factibilidad.

c) De igual manera se debe considerar si no sería más económico el promover el cultivo de trigo en la Costa y Sierra y aumentar la producción nacional en unas 30.000 toneladas, a fin de reducir la importación de trigo al mismo nivel del Programa de Harinas Compuestas. Después de todo, con este incremento de 30.000 toneladas de trigo, el país alcanzaría el mismo nivel de la cosecha de trigo de 1975. Las variedades de semilla escogidas por el INIAP dan un buen rendimiento y un alto contenido proteico en la Costa. En el Anexo I se demuestra claramente que al momento el cultivo de trigo no es atractivo para el agricultor.

d) Los programas de desarrollo de la producción de trigo y maíz para el país podrían muy bien considerarse conjuntamente. El impacto del ahorro de divisas que se acumularían, sería considerable, reduciendo las importaciones en unas 60.000 toneladas y nó solamente en 30.000 toneladas de trigo.

e) Todos estos cálculos están basados al nivel de consumo de harina de trigo de 1980. La tasa de incremento anual es de un 4% a 5% a largo plazo. Durante los últimos cuatro años, el aumento fue de más o menos 8% anual. Por lo tanto, es razonable considerar que para 1985, el 10% de trigo importado representará unas 40.000 toneladas de maíz nacional. Estas son las bases usadas para el cálculo de los costos de procesamiento para la harina compuesta y la capacidad de molienda del país.

f) Si la Harina Compuesta es económicamente factible, ésta podría producirse con harinas de trigo y maíz hasta que la harina de soya esté disponible en las plantas de extracción de soya.

2. Costos de la Harina Compuesta.-

Dos alternativas deben considerarse para el procesamiento de maíz:

a) El procesamiento del grano en harina podría hacerse en un solo molino, para todo el país, localizado cerca de las áreas de cultivo. La harina será luego distribuída a 3 molinos de trigo de la Costa y los 18 molinos pequeños de trigo de la Sierra. Estos molinos mezclarán la harina de maíz con la de trigo antes de

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1/ Los aceiteros estiman una importación en este año de aproximadamente 10.000 TM de

almacenarlas y embolsarlas para entregarlas a las panaderías.

b) Se podría instalar un molino de maíz solamente para los 18 molinos pequeños de la Sierra. Los 2 molinos grandes de trigo en Guayaquil, que producen cerca del 56% de harina de trigo, estarían equipados con sus propias plantas procesadoras de maíz.

En cuanto a la soya, la planta procesadora que produce aceite y harina desgrasada de soya proveerá a cada molino y la mezcla se hará añadiendo esta harina a la ya mezclada con los ingredientes y otros mejorantes de la harina. Como el porcentaje de incorporación es solamente del 3%, no habrá dificultad, excepto en instalar un pequeño dosificador al final de cada línea antes de que el producto sea embolsado. El costo de la soya no está considerado aquí. El precio de la harina dependerá del precio del producto principal, aceite y torta que serán procesados de semillas de algodón y soya. Un estudio de factibilidad llevado a cabo por la EPN/IIT en 1979, dió un precio de venta de la harina de soya de S/. 504.55/quintal. (Perfil industrial de una planta procesadora de harina de soya para consumo humano. EPN/MAG). Pero OLEICA podría producir y vender harina de soya a un precio más interesante.

Las cantidades de harina de maíz y soya para cada uno de los molinos están calculadas en el Anexo 3, en base a la producción de harina de trigo del año 1977/78, para tener una idea sobre las cantidades que necesitará cada molino.

Primera Alternativa.-

En esta alternativa, solamente un molino de maíz será construído y proveerá de esta harina a todos los molinos de trigo en el país. Cada molino de trigo deberá estar equipado con un depósito adicional al final de la línea para guardar la harina de maíz y con una mezcladora de harina, requiriendo de esta manera de espacio, ya sea en el suelo o en el primer piso del molino.

La harina de trigo y la de soya serán añadidas al mismo tiempo con los otros aditivos. Esta solución es la más conveniente, ya que la operación de mezcla es muy simple y conocida por los molinos y requiere solamente de una pequeña inversión. (De 8.000 a 20.000 dólares). El molino deberá estar localizado en el área productora, en las provincias del Guayas y Manabí. Los cálculos han demostrado que, a pesar de que los costos de mano de obra y energía son mayores en la Costa que en la Sierra, resulta más caro el transporte del maíz a la Sierra. 1/

El molino será abastecido con maíz seco al granel de la Red de Silos del Litoral, por la ENAC, y por lo tanto almacenará la materia prima por 15 días, al granel y por un máximo de 8 días el producto procesado y los derivados. La capacidad instalada será de 40.000 TM por año de 300 días laborables, o 130 toneladas/día, en 3 jornadas. El molino producirá harina, gérmenes y afrecho en las siguientes proporciones: Harina 70%, con menos del 2% de grasa; Gérmenes: 8% y Afrecho y Alimento Animal: 22%.

Se ha considerado útil de calcular los costos de producción en esta alternativa como modelo que podría ser seguido para el cálculo de las otras alternativas dadas más adelante.

El cuadro No. 1 demuestra los costos de equipos e instrumentos basados en una pro-

1/ Estudio sobre Comercialización de Trigo y Productos Derivados. PNUD/FAO/ECU/76/007. 1980 MAG. Página 70.

puesta para la instalación de un molino de maíz en 1977 y ajustada a los precios de 1980. Datos más precisos y actualizados se obtendrán de una compañía representada en Quito, a fines de 1980. (Happle, Cía. Ltda).

Los costos de procesamiento están calculados en el cuadro No. 2, tomando estimados de costo de molienda para molino de trigo.

El costo calculado por quintal de harina de maíz, con un beneficio de S/. 20.00 por quintal para el molino es de S/. 391.84.

La producción de Harina Compuesta se realiza en los molinos de trigo. El costo de distribución de estos molinos y el costo de la harina de trigo/maíz/soya consta en el Cuadro No. 3.

Los resultados para esta primera alternativa se pueden resumir como sigue:

Precio de Venta de 1 qq. de Harina Compuesta: (1979/80)

	COSTA	SIERRA
Trigo 87%, Maíz 10%, Soya 3%	S/.279.17	S/. 280.70
Trigo 90%, Maíz 10%	271.44	272.64
Trigo 100%	253.00	253.00

Una mezcla de trigo subsidiado, maíz y soya cuesta S/. 26.17 más por quintal que actualmente la harina de trigo subsidiada para la Costa y S/. 27.70 para la Sierra.

El estudio de factibilidad deberá también analizar las ventajas de la incorporación de soya con un mayor valor nutricional (1% de proteína) comparado a un incremento de los costos de producción de S/. 7.73 más que para el pan de maíz y trigo solo.

El precio de venta de Harinas Compuestas, comparado al de la harina de trigo y sus diferentes subsidios están calculados en el Cuadro No. 4 y presentados bajo el numeral 3.

Segunda Alternativa.-

En esta alternativa, los dos molinos de trigo grandes de Guayaquil se equiparán con una línea de procesamiento de maíz para producir harina y mezclarla directamente con la harina de trigo que se produce. La capacidad de las líneas sería de 8.000 a 10.000 toneladas de maíz por año de 3-0 días laborables, pero puede ser más grande para la producción de otros derivados que interesen a los molineros, por ejemplo, la producción de alimentos balanceados. Según informaciones al tiempo que la Misión estuvo en Guayaquil, esta solución parece ser más interesante para los molinos más grandes.

Para los molinos de la Sierra con capacidad mucho menor, esta solución no es factible. Por lo tanto, es necesario hacer un estudio de factibilidad para un molino de maíz construído en la Sierra o en la Costa para proveer de harina de maíz a cada molino de la Región, de acuerdo con sus respectivas cuotas de trigo. La cantidad de maíz necesaria para estos molinos es de aproximadamente 18.000 TM o sea el 45% del total nacional (40.000 TM) para el Programa de Harinas Compuestas. La capacidad instalada para este molino de maíz será de 18.000 TM de 300 días laborables, o sea 60 toneladas/día en 3 jornadas, con el mismo rendimiento que en la primera alternativa, de harina, germen y subproductos.

El cálculo económico es el mismo que para la primera alternativa, con inversiones más bajas y probablemente costos de producción más altos por quintal de harina. Este cálculo y el de subsidio debe ser llevado a cabo por el Departamento de Agroindustrias a fines de Noviembre, con datos precisos de inversiones que se obtendrán de una compañía en Quito.

<u>Otras Alternativas de Producción</u>.-

- La producción de gritz de maíz en un molino especializado para posteriormente molerlos conjuntamente con los granos de trigo en cada uno de los molinos es otra posibilidad. Pero esta tecnología será difícil de controlar ya que no hay un molino piloto con cilindros para hacer las pruebas, debiéndose capacitar a los molineros con un diagrama reajustado, el cual probablemente llevará a un cambio de flujo en los molinos que involucra altos costos. Esta solución difícilmente será aceptada por la industria.

- En 1981, la Empresa OLEICA iniciará la producción de harina de maíz precocida con una capacidad de 70 toneladas diarias. Esta puede ser otra posibilidad de disponer de harina de maíz para el Programa de Harinas Compuestas. El precio de venta a los molinos sería de S/. 460/quintal, lo cual significa la necesidad de un subsidio probablemente alto. Es posible también que OLEICA esté interesada en producir harina de maíz cruda y por lo tanto ésta puede tener un precio más conveniente. La ventaja de esta alternativa sería poder implementar el programa a corto plazo.

  Sería también interesante considerar la posibilidad de que la planta de OLEICA produzca harina de maíz exclusivamente para los molinos de la Sierra, mientras que los de la Costa pueden instalar sus propias líneas de producción.

- En todas las alternativas consideradas hasta aquí, la harina compuesta sería producida en los molinos de trigo y distribuída por ellos a las panaderías. Pero puede ser también una posibilidad que el molino de maíz distribuya la mezcla de harina de soya y maíz directamente a las panaderías, en proporción a la cantidad de harina de trigo que ellas empleen mensualmente. Esto crearía dos dificultades principales:

  a) El costo muy elevado de transporte y distribución a las 5.000 o 6.000 panaderías del Ecuador.

  b) La imposibilidad de controlar las cuotas de cada panadería y el uso de la fórmula para la harina compuesta. Por lo tanto, esta alternativa debe ser eliminada.

3. <u>La necesidad y el valor del subsidio</u>.-

El sistema de precios de harina de trigo y pan en el Ecuador se basa en un subsidio pagado por el Gobierno a fin de mantener el precio del pan al mismo nivel desde el año 1973, sin considerar el precio del trigo, ya sea importado o local.

El maíz ecuatoriano a ser usado en la Harina Compuesta es más caro que el trigo importado, que se beneficia del subsidio (Ver Anexo 4). Por lo tanto, un estudio de factibilidad debería: a) Calcular el precio real de la Harina Compuesta y el subsidio que debe ser aplicado al usar maíz local y conservar el precio del pan al nivel actual; b) Comparar este subsidio con el que beneficia al trigo importado. El subsidio para la Harina Compuesta podría ser igual o más bajo. De esta manera, el programa podría ser más económico para el Gobierno que con el sistema actual. Si el subsidio resulta más alto, podría haber una conclusión discutible: El Gobierno podría ahorrar divisas, pero necesitaría más sucres que ahora para apoyar este programa de producción de pan y el desarrollo de la producción de maíz.

La posibilidad de eliminar todos los subsidios para el trigo, harina y pan se ha discutido ya en el Informe UNDP/FAO/ECU/78/007, titulado "Estudio sobre la Comercialización del Trigo y Productos Derivados". Julio de 1980. También la Dirección de Comercialización y Empresas del MAG ha estudiado diez alternativas de precios para eliminar los subsidios en 1979 y 1980 y en caso de adoptarse alguna de estas proposiciones, el precio del maíz se haría más bajo que el de trigo importado.

El abandono del sistema de subsidio favorecería de cualquier manera al Programa de Harinas Compuestas.

El subsidio requerido para la producción nacional de harina compuesta está calculado en el Cuadro No. 4, asumiendo que los molinos deben mantener su ganancia al mismo nivel actual. En este caso, el subsidio sería de S/.26.17/qq. de harina compuesta con soya, en la Costa y de S/.27.70/qq. en la Sierra, al precio actual de S/.253/qq. de harina a las panaderías.

Es claro que con el sistema de subsidio actual, la producción de harina compuesta es más cara que la de harina de trigo sola. Y esto es válido con cualquier alternativa para el procesamiento de la harina de maíz y de soya, pero es muy importante señalar las siguientes ventajas para la economía nacional realizando el cálculo real de los costos para el Gobierno del Ecuador. Considerando que las importaciones de trigo en 1979/80 alcanzan las 300.000 TM, el país, de haber implementado un Programa de Harinas Compuestas hubiera reducido la importación de trigo en un 13% (componente sustitutivo 10% maíz y 3% soya) equivalente a 39.000 TM. Esto representaría un ahorro de divisas del orden de US$9.100.000 a un precio promedio de US$233/TM. Además el subsidio que se dejaría de pagar, correspondiente al trigo y a la harina alcanza para esta cantidad un ahorro adicional de S/.117.100.000, equivalente a US$4.600.000.

Estos US$13.700.000 (S/.343.300.000) comparados con los costos de producción de harinas compuestas, incluyendo maíz y soya, que alcanzan US$11.700.000 (S/.293.200.000) originarían un ahorro de US$2.000.000 (S/.50.800.000). Esta gran ventaja es la utilización de aproximadamente 32.000 TM de maíz y 12.000 TM de soya con el correspondiente ingreso para los agricultores e industriales del país. El detalle de los cálculos se encuentra en el Cuadro No. 4.

El Cuadro No. 5 presenta una gráfica que ilustra la relación del precio de la harina compuesta en función del subsidio total de trigo y harina. El punto de equilibrio se encuentra aproximadamente a un precio de subsidio total para harina de trigo de S/. 202/quintal.

4. Cuadro Institucional.-

Cualquier programa de harinas compuestas a nivel nacional requiere de la creación de un Comité Gubernamental, compuesto de los Ministerios pertinentes, que será responsable de la definición de la política a seguir para la implementación del programa bajo la autoridad del Ministerio de Gobierno. Se sugiere que este Comité esté integrado por el MAG como Secretaría Ejecutiva y los Ministerios de Finanzas y de Industrias, el CONADE y la Corporación Financiera Nacional.

También se sugiere la formación de un Comité para estudiar y preparar todos los documentos requeridos por el Comité Gubernamental y para ejecutar sus decisiones. La Comisión deberá incluir las siguientes instituciones: MAG, CENDES, Ministerio de Finanzas, CONADE, Ministerio de Industrias, Escuela Politécnica Nacional/IIT, INEN, INIAP y representantes de la industria molinera y de los panaderos. Para evitar una dispersión de esfuerzos se deberá limitar el número de miembros del Comité de 10 a 12 representantes.

Los términos de referencia de esta Comisión deberán incluir lo siguientes:

1. La selección de la alternativa más apropiada para la producción de harina de maíz y soya en base al estudio de factibilidad que debe hacer el MAG y presentarla al Comité con una definición de un programa de implementación, inclusive de un programa de promoción de la producción de trigo, maíz y sorgo nacional.

   Para la soya ya existe un programa de desarrollo a través del Programa Nacional de Oleaginosas.

2. El estudio y establecimiento de una compañía estatal o mixta para la producción de harina de maíz para lo cual deberá afrontar la construcción de la infraestructura necesaria. El estudio debería ser presentado al Comité y las decisiones las debe tomar el Frente Económico Nacional.

3. El estudio y la creación, después de las decisiones acordadas por el Comité, de un esquema crediticio para el financiamiento de equipo adicional requerido en los molinos pequeños para la mezcla y en los grandes molinos para la línea de producción de harina de maíz, y el estudio de todas las otras posibilidades de facilidades bancarias.

4. La preparación de un Decreto a través del cual se obliga a todos los molinos de trigo de añadir un 10% de harina de maíz y un 3% de harina de soya a todas las harinas de trigo. También deberá indicarse la cantidad de mejorantes a utilizarse. Una implementación progresiva podría analizarse y autorizar la inclusión de solamente un 5% de harina de maíz para el primer año. Las cuotas de harinas de maíz y soya a ser distribuída mensualmente a cada uno de los molinos también tendrá que ser incluída. El Decreto deberá ser discutido en el Comité con los representantes de la industria molinera antes de ser endosado y publicado por el Comité.

5. El control de la aplicación del Decreto arriba mencionado y la inspección de los molinos, panaderías y plantas productoras de fideos para asegurar que las cuotas de harina están siendo respetadas y las especificaciones alcanzadas. La Comisión podrá delegar sus responsabilidades en este asunto a alguna institución existente como por ejemplo el INEN. Deberá también desarrollarse un procedimiento para discutir y solucionar los problemas y responder a posibles reclamos por parte

de la industria y de los consumidores en lo que se refiere a la calidad de la harina producida.

6. La selección de una institución a cargo de entrenar y asesorar a los molineros, panaderos y productores de fideos en la utilización de las harinas compuestas. Esta institución podrá ser la Escuela Politécnica Nacional, la cual ha estado muy activa y está capacitada para la producción y utilización de harinas compuestas. Esta institución deberá regularmente analizar las muestras de harina y sus productos solicitados por la industria.

7. Los cálculos de los precios y costos de la soya y maíz y otras informaciones requeridas por el Comité, así como la situación de abastecimiento cada año para fijar las cuotas y los precios de las harinas compuestas a las panaderías.

CUADRO No. 1

ESTIMACION DE INVERSIONES PARA UN MOLINO DE MAIZ DE 130 TNS/DIA.

1. EDIFICIOS:		
- Silos (1)	S/.	22.400.000
- Edificio de la planta (2 pisos) 300 m2 x S/. 5.000/m2		1.500.000
- Oficinas: 50 m2 x S/. 5.000/m2		250.000
- Almacenes (1)		1.050.000
Subtotal:	S/.	25.200.000
2. EQUIPOS:		
- Equipo de desgerminación y molienda, FOB (2)		34.000.000
- Transporte al Ecuador y al sitio (15%)		5.100.000
- Misceláneos: 10% de equipo		3.400.000
Subtotal:	S/.	42.500.000
3. EQUIPO DE OFICINA		100.000
Total Inversiones:	S/.	67.800.000
AMORTIZACION:		
- Edificios 3%	S/.	756.000
- Equipo, 5%		2.125.000
Total:	S/.	2.881.000
COSTOS DE MANTENIMIENTO:		
- Edificios, 0.5%		126.000
- Equipo, 1%		425.000
Total:	S/.	551.000

(1) Silos: Maíz, 2.000 T. de capacidad, en 8 baterías de 250 T.
Harina, 900 T. de capacidad, en 6 baterías de 150 T.

Almacenes: Subproductos, 240 T. de capacidad, en almacén de 30x20x5 m.
Costo por capacidad instalada: Silos = S/.7.000/T.; Almacenes: S/.3.500/m2

(2) Incluyendo costos de construcción en el sitio, instalación eléctrica y repuestos. Estimación en base a presupuesto de 1977 actualizado.

CUADRO No. 2

COSTO DE PRODUCCION DE LA HARINA DE MAIZ

(Por qq. de Harina).

Materia Prima (143 Lbs. a S/.280/qq).	S/. 400.40	
Transporte	5.00	
Almacenamiento	5.00	
Molienda (1)	73.00	
Total Costo:	S/. 483.40	
Utilidad (2)	20.00	
Sobtotal:		S/.503.40
Ingresos:		
Venta germen (3)	S/. 48.64	
Venta subproductos (4)	S/. 62.92	
	S/. 111.56	
Balance (Precio de Venta de la Harina de Maíz, ex-molino)		S/.391.84

NOTA: El maíz será entregado al molino de maíz por la Empresa Nacional de Almacenamiento y Comercialización, (ENAC) cada dos semanas, con un contenido estandar de humedad del 14%. El secado del maíz será realizado al entrar la cosecha, por la ENAC. Se asume que el costo de secado es absorbido por el menor precio pagado al agricultor según la tabla establecida. Por lo tanto, el precio de maíz en el molino, fue calculado solo con los costos estimados de transporte desde los silos de la ENAC y los costos de almacenamiento.

(1) Estimados basados en los costos promedio de la industria.

(2) Similar a la utilidad estimada para la industria molinera de trigo.1979/80.

(3) 8% x 143 Lbs. x S/.420/qq.

(4) 22% x 143 Lbs. x S/.200/qq.

Appendix D

COSTO DE PRODUCCION DE UN QUINTAL DE HARINA COMPUESTA

MATERIA PRIMA	MOLINOS DE LA COSTA			MOLINOS DE LA SIERRA		
	SUCRES POR QUINTAL	MEZCLA %	TOTAL	SUCRES POR QUINTAL	MEZCLA %	TOTAL
A. TRIGO: 87%, MAIZ: 10%, SOYA: 3%						
1. MATERIA PRIMA:						
1.1 Harina de Maíz	391.84 (1)			391.84 (1)		
Transporte al Molino de Trigo	5.00 (2)			16.00 (2)		
Almacenamiento	1.50			1.50		
	398.34	0.10	39.83	409.34	0.10	40.94
1.2 Harina de Soya	484.41 (3)			484.41 (3)		
Transporte al Molino de Trigo	5.00			16.00		
Almacenamiento	1.50			1.50		
	490.91	0.03	14.72	501.91	0.03	15.05
1.3 Harina de Trigo (inc.utilidad)	253.00	0.87	220.11	253.00	0.87	220.11
2. MEZCLA (4)			2.00			2.00
3. UTILIDAD POR HARINA DE SOYA Y MAIZ (S/.20.- x 0.13)			2.60			2.60
PRECIO DE VENTA DE 1qq. DE H.COMPUESTA:			279.26			280.70
B. TRIGO: 90%; MAIZ: 10%						
1. MATERIA PRIMA:						
1.1 Harina de Maíz			39.83			40.94
1.2 Harina de Trigo	253.00	0.90	227.70	253.00	0.90	227.70
2. MEZCLA			2.00			2.00
3. UTILIDAD POR HARINA DE MAIZ (S/.20.- x 0.10)			2.00			2.00
PRECIO DE VENTA DE 1qq. DE H. COMPUESTA:			271.53			272.64

(1) Ver Cuadro No. 2. (2) Comercialización de Trigo y Productos Derivados, MAG/FAO/ECU/78/007. Julio 1980.
(3) Costo: S/.484.41. FUENTE: Perfil Industrial de una Planta productora de Harina de Soya. MAG/IIT,1979.
(4) Estimado provisional.

ELABORACION:Depto.Agroindustrias, MAG.

CUADRO No. 4

EVALUACION DEL SUBSIDIO PARA HARINA COMPUESTA

A. COSTO DE IMPORTACIONES DE TRIGO PARA EL GOBIERNO EN 1980

En el caso de que las importaciones sean de 300.000 TM y que el promedio anual sea el del último embarque, US$233/TM:

1.	Valor	US$ 69.9 Millones	=	S/. 1.747.5 Millones (1)
2.	Subsidio Trigo (2)	US$ 28.6 Millones	=	S/. 715.0 Millones
3.	Subsidio Harina (3)	US$ 7.5 Millones	=	S/. 186.1 Millones
	TOTAL COSTO:	US$106.0 Millones	=	S/. 2.648.6 Millones

B. COSTO DE 13% DE IMPORTACION DE TRIGO A SUSTITUIRSE CON HARINAS COMPUESTAS

Importación = 13% x 300 TM = 39.000 TM.

1.	Valor	US$ 9.1 Millones	=	S/. 227.2 Millones
2.	Subsidio Trigo+Harina	US$ 4.6 Millones	=	S/. 117.1 Millones
	TOTAL COSTO:	US$ 13.7 Millones	=	S/. 344.3 Millones.

C. COSTO UTILIZACION SOYA Y MAIZ (3)

	TOTAL C:	US$ 11.7 Millones	S/. 293.2 Millones
D.	AHORROS B - C	US$ 2.0 Millones	S/. 51.1 Millones

(1) US$1.- = S/.25.-
(2) US$233/TM Menos Precio Referencial de US$137.74/TM = US$95.26/TM. = S/.108.25/qq.
(3) Ver páginas siguientes

E. PRECIOS DE HARINAS COMPUESTAS

FORMULA CON MAIZ Y SOYA:	COSTA	SIERRA
Precio Venta Harina Compuesta (1)	S/.279.26/qq	S/.280.70/qq.
Precio Venta Harina Trigo	S/.253.00/qq.	S/ 253.00/qq.
SUBSIDIO ADICIONAL:	S/. 26.26/qq.	S/. 27.70/qq.

FORMULA CON MAIZ SIN SOYA:		
Precio Venta Harina Compuesta (1)	S/.271.53/qq.	S/.272.64/qq
Precio Venta Harina Trigo	253.00/qq	253.00/qq.
SUBSIDIO ADICIONAL:	S/. 18.53/qq.	S/. 19.64/qq.

(1) Ver Cuadro No. 3

CUADRO No. 4 (2)

F. SUBSIDIO OFICIAL PARA EL TRIGO IMPORTADO Y HARINA DE TRIGO (1980)

1. SUBSIDIO EN EL TRIGO IMPORTADO:

Precio CIF, Guayaquil		US$233.00/T
Precio Referencial		137.74/T
	SUBSIDIO:	US$ 95.26/T.
	EQUIVALENTE A:	S/.143.97/qq. de harina.(1)

2. SUBSIDIO EN HARINA DE TRIGO:

Costa:	S/. 33.69/qq. de harina
Sierra:	S/. 42.58/qq. de harina

3. TOTAL DEL SUBSIDIO:

Costa:	S/.177.66/qq.
Sierra:	S/.186.55/qq.

(1) 1.33 qq. de trigo = 1 qq. de harina.

CUADRO No. 4 (3)

DETALLE DEL CALCULO (A2)

SUBSIDIO HARINA DE TRIGO IMPORTADO

A. Producción de harina a partir del trigo importado:

300.000 TM a 75% tasa de extracción = 225.000 TM de harina.

- Distribución de la producción de harina por región:

Costa: 56% de la producción de harina = 126.000 TM.
Sierra: 44% = 99.000 TM

B. Subsidio:

COSTA:	126.000/TM	x 22/qq.	x S/.33.69/qq.	= S/.93.4 Millones
SIERRA:	99.000/M	x 22/qq.	x S/.42.58/qq.	= S/.92.7 Millones
TOTAL:				S/.186.1 Millones.

Estos 186.1 Millones de sucres son equivalentes a US$7.5 Millones de dólares.

CUADRO No. 4 (4)

DETALLE DEL CALCULO (C)

C. COSTO DE HARINAS COMPUESTAS:

1. Materia prima de substitución:
   Las 39.000 TM de trigo a sustituir con maíz y soya son equivalentes a 29.250 TM de harina a 75% de extracción, a repartir entre harina de maíz y harina de soya.

- Harina de Maíz = $\frac{29.250 \times 10}{13}$ = 22.500 TM (Equivalente a 32.100 TM de maíz)

  De los cuales: COSTA = 12.600 TM
  SIERRA = 9.900 TM.

- Harina de Soya = $\frac{29.250 \times 3}{13}$ = 6.750 TM (Equivalente a 11.700 TM de soya)

  De los cuales: COSTA: 3.850 TM
  SIERRA: 2.950 TM

TOTAL PARA LA COSTA: 16.400 TM
TOTAL PARA LA SIERRA:12.850 TM

2. COSTO UTILIZACION HARINAS DE MAIZ Y SOYA:

	COSTA		SIERRA	
	PRECIO/qq.(1)	TOTAL	PRECIO/qq.	TOTAL
Harina de Maíz	S/.297.34	S/.110.0 Millones	S/.409.34	S/. 90.0 Millones
Harina de Soya	S/.490.91	S/. 41.0 Millones	S/.501.91	S/. 32.6 Millones
Mezcla	S/. 2.00	S/. 0.7 Millones	S/. 2.00	S/. 0.7 Millones
Utilidad	S/. 2.60	S/. 0.9 Millones	S/. 2.60	S/. 0.9 Millones
Subsidio	S/. 26.17	S/. 9.4 Millones	S/. 27.70	S/. 7.8 Millones
TOTAL C:		S/.162.0 Millones		S/.130.7 Millones

(1) Cuadro 3.

3. TOTAL COSTO UTILIZACION SOYA Y MAIZ

COSTA:	US$ 6.5 Millones	=	S/.162.0 Millones
SIERRA:	US$ 5.2 Millones	=	S/.130.7 Millones
TOTAL:	US$11.7 Millones	=	S/.292.7 Millones

CUADRO No. 5

PRECIO DE LA HARINA COMPUESTA EN EL MOLINO DE TRIGO PUESTA EN SACOS. SI EL SUBSIDIO DE LA HARINA DE TRIGO SUSTITUIDA ES USADO PARA SUBSIDIAR LAS HARINAS DE MAIZ Y SOYA.

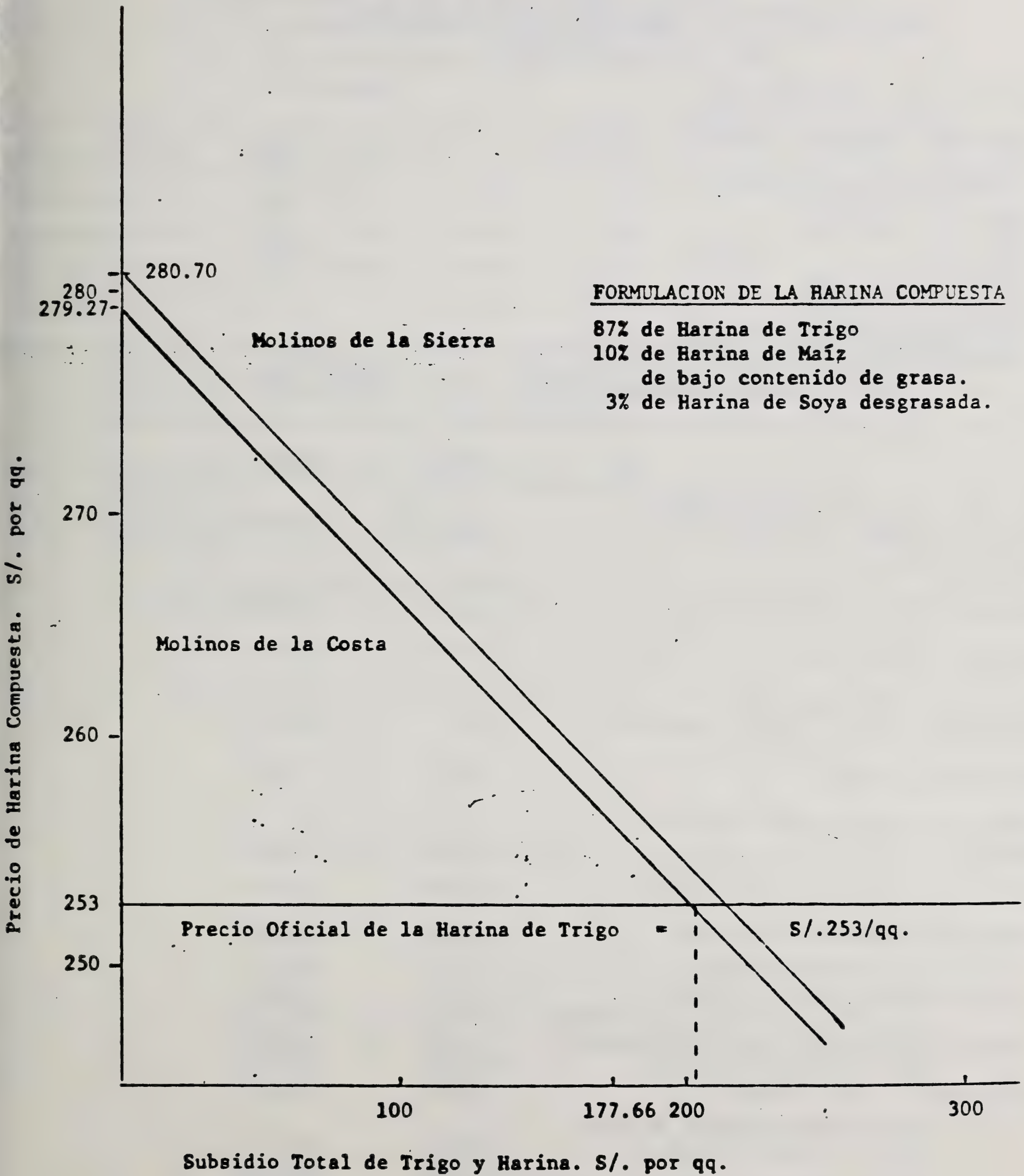
PRECIOS USADOS EN EL CALCULO, SUCRES/qq.

	COSTA	SIERRA
Harina de Trigo	253.00	253.00
Harina de Maíz	391.84	391.84
Transporte al Molino de Trigo	5.00	16.00
Almacenamiento en Molino de Trigo	1.50	1.50
Costo total de Harina de Maíz	398.34	409.34
Harina de Soya	484.41	484.41
Transporte al Molino de Trigo	5.00	16.00
Almacenamiento en Molino de Trigo	1.50	1.50
Costo total de Harina de Soya	490.91	501.91
Costo de la Mezcla:	2.00	2.00

FUENTE: D. Fellers, Mision Harinas Compuestas, USAID.

CUADRO No. 5 (2)

GRAFICO QUE RELACIONA EL PRECIO DE LA HARINA COMPUESTA CON EL SUBSIDIO TOTAL DE TRIGO Y HARINA.



CUADRO No. 6

CALCULO DE COSTOS Y SUBSIDIOS DE HARINA DE TRIGO

(Estimado de Agosto 1980)

COSTO Y FLETE (C&F) GUAYAQUIL:	US$128.76
Intereses 13% anual (90 días)	3.22
Timbres 5 x 1000	0.6438
Tasas estadísticas 6x100	0.7726
Tasas de servicio 1%	1.2876
Apertura de L/C.1%	1.2876
Merma 1%	1.2876
Seguros 3.75 x 1000	0.4828
Derechos Portuarios	-
Descarga Autoridad Portuaria	-
Impuesto eslora	-
Precio Referencial/TM:	US$137.7420

	COSTA	SIERRA
Valor qq. trigo importado ex-Aduana en sucres (1/TM = 21.739qq.) en silos puerto.	158.40	158.40
Transporte silos puerto-molinos	-.-	17.00
Valor de qq. en molino:	158.40	175.40
Precio qq. trigo nacional (131.58 Lbs trigo = 100 Lbs. harina)	330.-	330.-
Transporte, estiva	21.-	3.-
Precio qq. trigo nacional en silo, molino	351.00	333.00
92.65% trigo importado (121.90 Lbs)	193.09	213.81
7.36% trigo nacional (9.68 Lbs)	33.98	32.23
Costo Materia Prima:	227.07	246.04
- Valor subproductos: S/.160/qq)	39.34	39.34
Costo Materia Prima para Harina:	187.73	206.70
+ Costo Procesamiento (inc.depreciación)	78.96	68.88
Costo Quintal de Harina:	266.69	275.58
+ Utilidad S/. por quintal	20.00	20.00
Valor Quintal Harina de Trigo para la venta al público:	286.69	295.58
Precio Oficial Harina de Trigo:	253.00	253.00
SUBSIDIO POR QUINTAL HARINA DE TRIGO PRODUCIDA:	33.69	42.58

FUENTE: Departamento de Importación MICEI, Junio 1980.
Dirección General de Comercialización y Empresas, MAG.

ANEXO 1

RENTABILIDAD APARENTE DEL CULTIVO DE TRIGO COMPARADA CON LA DE OTROS CULTIVOS

(Utilidad aparente. Sucres por Ha.)

FORMA DE CULTIVO	TRIGO	MAIZ	ARVEJA	FREJOL	LENTEJA	CEBADA	PAPA
Tradicional	460	9.764	2.997	4.950	5.022	6.679	10.284
Semitecnificado	1.484	4.039	6.252	7.366	-	-	17.422
Tecnificado	2.952	8.850	11.352	12.614	13.394	-	34.209

FUENTE: Elaborado en base a los costos de producción calculados por las Direcciones Zonales del MAG de Tungurahua y Chimborazo y la Jefatura Provincial de Bolívar. Estudio PNUD/FAO/ECU/78/007 sobre la Comercialización de Trigo y Productos Derivados. Julio de 1980. Página 26.

NOTA: Costos establecidos con rendimiento de trigo:

Tradicional	S/.260.85/qq.	Rendimiento	17 qq/Ha.
Semitecnificado	251.44/qq.	"	25 "
Tecnificado	232.22/qq.	"	35 "

Precio de Trigo: 250 sucres/quintal.

ANEXO 2

CONTENIDO PROTEICO DE LAS HARINAS COMPUESTAS

1. CON TRIGO DE ALTO CONTENIDO PROTEICO (13.1%)

Harina de Trigo:	0.87 x 13.1%	=	11.39
Harina de Maíz:	0.10 x 8.5%	=	0.85
Harina de Soya:	0.03 x 54.5%	=	1.63
Total Contenido Proteico de la H.C.		=	13.87

2. CON TRIGO DE BAJO CONTENIDO PROTEICO (10.2%)

Harina de Trigo:	0.87 x 10.2%	=	8.87
Harina de Maíz:	0.10 x 8.5%	=	0.85
Harina de Soya:	0.03 x 54.5%	=	1.63
Total Contenido Proteico de la H.C.		=	11.35%

Al añadir un 3% de soya se compensa la deficiencia proteica de la harina de maíz en la mezcla. El contenido proteico varía entre el 0.77 y 1.15% entre las dos clases de trigo, lo cual no es significante.

Sin embargo, la presencia de Lysina en la harina de soya contribuye a mejorar el equilibrio en aminoácidos de la harina compuesta, supliendo así la deficiencia de Lysina del maíz y del trigo.

CALCULO DE LOS REQUERIMIENTOS DE MAIZ Y SOYA POR MOLINO PARA EL PROYECTO DE HARINAS COMPUESTAS

(Cifras en Toneladas Métricas)

MOLINOS	LOCALIZACION	CAPACIDAD MOLIENDA	AÑO: 1977/78 CAPACIDAD UTILIZADA TM	%	EXTRACCION H.DE TRIGO 75%	CUOTA DE H. DE MAIZ 10%	CUOTA DE H. DE SOYA 3%	REQUERIMIENTOS DE GRANO MAIZ (1)	SOYA (2)
SIERRA:									
Ingueza	El Angel	3.970	2.696	68	2.022	202	61	288	105
San Luis	San Gabriel	6.098	4.353	71	3.265	326	98	466	169
La Unión	Cayambe	29.781	26.514	89	19.886	1.989	597	2.841	1.029
Ind.Harinera SA.	Quito	31.200	5.754	18	4.316	432	129	617	222
Censo	Quito	9.360	7.155	76	5.366	537	161	767	278
Royal	Quito	17.000	16.667	95	12.500	1.250	375	1.786	647
Santa Rosa	Quito	6.807	2.381	37	1.786	179	54	256	93
Superior	Quito	19.244	13.133	68	9.850	985	296	1.407	510
Pan Nuestro	Quito	1.418	195	14	146	15	4	21	7
Cóndor	Quito	5.672	3.824	67	2.868	287	86	410	148
Poultier	Latacunga	12.338	11.266	91	8.450	845	254	1.207	438
Pastificio	Ambato	6.523	4.387	67	3.290	329	99	470	171
Friedman	Ambato	5.389	1.484	28	1.113	113	33	161	57
Miraflores	Ambato	8.509	4.377	51	3.283	328	98	469	169
Fénix	Riobamba	9.218	6.176	67	4.632	463	139	661	240
Puyol	Riobamba	8.509	2.519	30	1.889	189	57	270	98
Electro Mod.	Cajabamba	4.645	2.233	48	1.675	167	50	239	86
Ecuador	Cuenca	6.381	5.310	83	3.983	398	119	569	205
Italia	Cuenca	5.105	-	-	-	-	-	-	-
		197.167	120.424 (3)	61%	90.320	9.034	2.710	12.905	4.672
COSTA:									
Mol.del Ecuador	Guayaquil	93.600	64.498	69	48.374	4.837	1.451	6.910	2.502
Ind. Molinera	Guayaquil	102.960	80.818	78	60.614	6.061	1.818	8.659	3.134
Ind. Harinera	Guayaquil	4.680	2.995	64	2.246	225	67	321	116
		201.240	148.311 (3)	73%	111.234	11.123	3.336	15.890	5.752
TOTALES:		398.407	268.735 (3)	67%	201.554	20.157	6.046	28.795	10.424

FUENTE: Comercialización de Trigo y Productos Derivados MAG/FAO. Julio de 1980.
ELABORACION: Departamento de Agroindustrias.
(1) Factor de Extracción 70%
(2) Factor de Extracción 58%
(3) La capacidad utilizada nacional se componer de 56% en la Costa y 44% en la Sierra.

ANEXO 4

PRECIOS DE GRANOS BASICOS EN EL ECUADOR FIJADOS POR EL GOBIERNO.

(Vigentes en Noviembre de 1980)

A. TRIGO NACIONAL

Decreto 0339 de 18 de Agosto de 1980. Resolución del Frente Económico de 27 de Diciembre de 1979.
A partir del 1º de Julio de 1980 el precio del trigo nacional, a nivel de finca es de:

S/. 330/quintal.

Requerimientos:	Peso hectolítrico	72 puntos
	Humedad	15%
	Impurezas	2%
	Peso del quintal	45.36/Kg = 100 libras netas.
	Peso hectolítrico determinado mediante muestra limpia.	

Castigos o compensaciones por variaciones del peso hectolítrico:

Peso Hectolítrico Puntos	Precio Sucres
70	321.oo
71	325.50
72	330.00
73	334.50
74	339.00
75	343.50
76	348.00
77	352.50
78	357.00
79	361.50
80	366.00

Bajo 70 puntos serán de libre comercialización.

Obligaciones: Las Empresas Molineras y la ENAC están obligadas a comprar toda la producción nacional al momento que se presente cualquier oferta.

Equivalente del precio:

1 libra	= 3.30 sucres	= US$ 0.12
1 quintal	= 330 sucres	= US$ 12.-
1 TM	= 7.273.20 sucres	= US$264.48
1 Kg.	= 7.2732 sucres	= US$0.26448

1 TM = 22.04 quintales
1 US$ = 27.50 sucres

ANEXO 4/2

B. TRIGO IMPORTADO

Compra por el Gobierno el 12 de Octubre de 1980:
Precio C&F Guayaquil:
US$233/TM = S/.6.407.50/TM (S/.290.72/qq.)

Compra por el Gobierno el 25 de Octubre de 1980:
Precio C&F Guayaquil:
US$243.80/TM = S/.6.704.50/TM. (S/.304.19/qq.)

Precio de referencia. Ex-Aduana:
US$137.74/TM.

C. HARINA DE TRIGO

Precio Oficial:
US$9.20/qq. = S/.253.00/qq.
US$202.76/TM. = S/.5.576.12/TM.

Subsidio Resolución Transitoria del Frente Económico, que involucra incremento reciente de salarios e incremento de precio nacional:

Para Molinos de la Sierra:
US$33.66/TM = S/.925.68/TM (S/.42.-/qq = S/.0.92568/Kg. = S/.0.42/Lb.

Para Molinos de la Sierra:
US$26.44/TM = S/.727.32/TM. (S/.33.-/qq = S/.0.72732/Kg. = S/.0.33/Lb.

Precio Total de la Harina:

Sierra: US$236.42/TM = S/.6.501.80/TM.
(S/.295/qq. = S/.6.5018/Kg. = S/.2.95/Lb.)

Costa: US$229.21/TM = S/.6.303.44/TM.
(S/.286/qq. = S/.6.30344/Kg. = S/.2.86/Lb.)

Este subsidio será aparentemente válido hasta el 31 de Diciembre, 1980. A partir del 1º de Enero de 1981, probablemente se aumentará el precio de la harina al precio real, anulándose el subsidio.

D. MAIZ DURO NACIONAL

Por Resolución del Frente Económico de 26 de Diciembre de 1979, se fija el precio oficial para la compra-venta de maíz duro en:

Precio Oficial: S/. 280/qq.
con los siguientes requerimientos:

Peso de 122.	=	45.36/Kg.
Humedad	=	20%
Impurezas	=	3%

ANEXO 4/3

Existe una tabla de precios relacionada con el porcentaje de humedad e impurezas, que incluye el costo de secado y limpieza, equivalentes a:

S/.280/qq. = S/.6.160/TM = US$244/TM.

ENAC vende el maíz duro almacenado en sus instalaciones a:
S/.340/qq. = S/.7.480/TM = US$272/TM.

E. MAIZ IMPORTADO

El precio de Octubre de 1980, en el mercado internacional, es de:
US$141/TM, FOB Gulf, E.U. + Aproximadamente US$45/Transporte/Seguro,Guayaquil.
Se obtiene un costo de US$186/TM.

F. ARROZ NACIONAL

Por Acuerdo 106 del MAG, de 27 de Marzo de 1980, se fijan oficialmente los precios siguientes:

Requerimientos:	Grano partido	hasta 10%
	Humedad	20%
	Impurezas	5%
	Peso del quintal	45.26 Kg.
	Saco	No está incluído.

	farm NIVEL FINCA (qq)	mill NIVEL PILADORA (pilado - qq.)	wholesale NIVEL MAYORISTA (qq.) COSTA	SIERRA	Consumer CONSUMIDOR (Lb.) COSTA	SIERRA
Grano Largo	S/.240.-	S/.460.-	480.-	490.-	5.20	5.30
Grano Medio	230.0	450.-	470.-	480.-	5.10	5.20
Cuando el grano partido alcanza hasta el 15%, los precios fijados son:						
Grano Largo:	240.-	440.-	460.-	470.-	5.00	5.10
Grano Medio	230.0	430.-	450.-	460.-	4.90	5.00

EQUIVALENTES AL PRECIO DE:
(Grano Largo (hasta 10% partido)

Nivel de Finca: US$192.18/TM = S/.5.282.19/TM; US$8.72/qq. = S/.240.-/qq.

Nivel de Piladora:
Arroz Pilado: US$368.50/TM = S/.10.133.75/TM; US$16.72/qq. = S/.460.-/qq.

(Grano Medio, hasta 10% partido)

Nivel Finca.
Arroz cáscara: US$184.25/TM = S/.5.066.87/TM; US$8.36/qq. = S/.230.-/qq.

Nivel Piladora: US$360.57/TM = S/.9.915.67/TM; US$16.36/qq. = S/.450.-/qq.

ANEXO 4/4

Precio promedio del arrocillo: US$200.34/TM = S/.5.509.35/TM; US$9.09/qq.= S/.250%qq.

Precio promedio del polvillo: US$112.18/TM = S/.3.084.95/TM; US$5.09/qq.= S/.140/qq.

G. ARROZ IMPORTADO

Precio oferta de Septiembre de 1980:

1 TM de Arroz tipo Grano Medio: US$374, FOB Bogotá.
(S/.10.285/TM = S/.466.65/qq).

H. SEMILLAS CERTIFICADAS

TRIGO:	S/.585/qq.
MAIZ: Equivalente a	480/ funda de 60 Lbs. 800/qq.
ARROZ:	550/qq.
SOYA:	570/qq.
CEBADA	495/qq.

FUENTE:
Dirección General de Desarrollo Agrícola, MAG
Departamento de Precios, MAG
Departamento de Seguridad Alimentaria, MAG

ANEXO 5

LISTA DE PERSONAS Y COMPAÑIAS VISITADAS

ESCUELA POLITECNICA NACIONAL/INSTITUTO DE INVESTIGACION TECNOLOGICA

Ing. Jaime Velásquez, Director
Ing. Oswaldo Acuña, Investigador de Harinas Compuestas
Ing. Elman López, Responsable del Proyecto de Harinas Compuestas
Sr. Gonzalo Herández Salazar

MINISTERIO DE SALUD PUBLICA

Ing. Luis Ortiz, Director de la Planta Procesadora de Alimentos El Beaterio (Alimentos para infantes).

MINISTERIO DE AGRICULTURA Y GANADERIA (MAG)

Ing. Gerardo Paredes, Director General de Desarrollo Agrícola
Ing. Marcelo Morales, Director de Planeamiento de la Seguridad.
Econ. Saúl Pérez, Departamento de Agroindustrias, Dirección de Desarrollo Agrícola. Esta es la División encargada del Programa de Harinas Compuestas.
Sr. Herman Puyol, Departamento de Comercialización.
Ing. Jorge Gutiérrez, Asesor del señor Ministro de Agricultura (Ambato)

INSTITUTO NACIONAL DE INVESTIGACIONES AGROPECUARIAS (INIAP)

Ing. Miguel Rivadeneira, Seccción de Farinología, Estación Experimental Santa Catalina (25 Km. fuera de Quito).

HAPPLE, CIA. LTDA. Importadores de equipo molinero.

Ing. Emilio Happle, Gerente.
(Carcelén. Calle 2da, Lote No. 8. Casilla 4645-A, Quito).

DATOS ECUADOR, S.A.- Quito

ASOCIACION DE MOLINEROS DE LA SIERRA Y ECUAGRAN. Quito.

Ing. Patricio Hidalgo Pérez.- (Ave.Amazonas, Edif. de las Cámaras. Aptdo.547-A)

USDA. MISION DE HARINAS COMPUESTAS Y ALIMENTO PARA INFANTES

Sr. David Fellers, USDA, San Francisco, California.
Sra. Sandra Callier, USDA, Washington, DC.

USAID OFFICE EN QUITO

Sr. Fausto Maldonado, Oficina de Desarrollo Rural
Sr. Manuel Rizzo, Oficina de Salud.

ANEXO 5/2

PROGRAMA NACIONAL DE OLEAGINOSAS - Guayaquil

Sr. Mario Aguilera
Sr. Mauricio Vélez

EMPRESA OLEICA - Guayaquil

Sr. Luis Piana, Gerente General
Ing. Moreano, Director Técnico.

MOLINOS DEL ECUADOR - Guayaquil

Sr. Black, Gerente General
Sr. César Innocenzi, Gerente de Operaciones

MOLINOS ROYAL - Quito

MOLINO POULTIER - Latacunga

MALTERIA DE LA CERVECERIA ANDINA - Latacunga

VARIAS PANADERIAS, EN PARTICULAR:

PASTIPAN y MODERNA, en Quito
SUPAN, en Guayaquil.

***

THE CASE FOR SRI LANKA

Sri Lanka, an island off the south of India, has a population of about 14 million. It has a socialist government with elections due September 1977. It is anticipated that a change of government will take place, with a more rightist government expected, though still socialist-democratic. Both governments are committed to improving the social welfare of the populace. Of importance to WRRC's project, the government dominates and/or controls agricultural production, wheat importation, processing, distribution and price, and fixes the price of baked wheat products. The price of wheat flour and bread is subsidized.

Nutritional Status

The 1976 CSC Nutrition Survey clearly demonstrated nutritional problems with PCM, Vitamin A, Vitamin D, iron and calcium. The extent of these deficiencies are pinpointed on a regional basis in the 15 S.H.S. areas of Sri Lanka. The attached maps list the data for PCM, Vitamin A, and iron.

Wheat Situation

In 1976 GOSL imported ~137,000 MT of wheat, and 540,000 MT wheat flour (~ 800,000 MT wheat equivalent). The wheat is milled at one mill in Colombo. The allocation of locally milled wheat to the 15 SHS regions of SL is known on a tonnage basis, and as a percentage of the total flour requirement. Data for allocation and requirement is January 1977. Unfortunately, the totals do not add up to the above annual imports - discrepancy to be resolved. However, this implies that if the locally milled wheat was fortified at the mill, its destination on a geographic basis is known accurately, and can be correlated with nutritionally deprived regions. On a regional basis, the percentage of

flour consumed derived from locally milled wheat versus the total flour consumption is calculated as follows:

S.H.S. region	Percent flour derived from locally milled wheat	(Actual Tonnage/week)
Kandy	33	500
Matale	27	100
Galle	30	150
Matara	20	100
Kurunegale	63	500
Anuradhapura	53	200
Puttalam	33	50
Ratnapura	33	200
Kegalle	17	100
Badulla	24	200

It is thus easy to predict the consumption of fortified wheat flour on a regional basis, viz., predict the nutritional benefit(s) to be gained by the fortification program.

The manager of the mill, Mr. V.P. Silva, is in favor of nutritional improvement in foods; indeed, he is almost a food faddist - even to not eating his own milled wheat flour. He believed a vitamin-mineral modification to the mill was easily possible, but was concerned about the space requirements for a soy-wheat flour blending operation. Interestingly, a new mill is being drawn up (to be financed by Germany) which will include blending facilities for composite flours; but this is 8 years or so away.

Silva stated he would like to increase the wheat extraction rate "to make nutritionally superior flour," but is unable to do so because of "predicted" consumer complaints about color, but also because Sri Lanka derives

considerable foreign exchange through sale of the wheat milling byproduct as feed to Persian Gulf ports.

The present extraction rate is 75-76 percent.

WRRC has, on hand, copies of Ceylon Standard Specification for Wheat Flour, and Ceylon Standard Specification for White Bread. Optional ingredients include vitamins, minerals, dough conditioners, and soy flour, the latter not to exceed 5 percent of the flour. [This would easily be amendable to >5 percent, witness the care of adding 10 percent sorghum flour during 1976. WRRC knows the bureaucratic mechanism to solicit this change, if needed.]

Prices

GOSL buys flour from the State Flour Milling Association (the one mill) at 1850 rupees/L.T. (U.S. $255/L.T. or $0.114/lb.), which fluctuates slightly but approximately equal to landed price of PL-480 flour. The subsidized retail price for a one-pound loaf is 0.75 rupees (U.S. $0.10). Bran is sold locally for 750 rupees/L.T. (U.S. $103), but mostly exported at $110.50/L.T. Flour is sold locally at $0.11/lb. Consumption of wheat flour was estimated by the manager, Marketing Department Bakery (the State Bakery), to be ~75 percent through commercial baked products, and 25 percent home flour purchases, though the SL Deputy Food Commission believed it was 50:50. White pan bread is the most important commercial product, followed by sponge cakes, rolls and cookies. Home products included flat breads, stringhoppers, pittu and hoppers. This gentleman stated no problem anticipated with low soy levels (≯ 10 percent), but cautioned about the color.

The bread baking process in Sri Lanka consists of firing an oven with wood, raking out the ashes, then putting in the pans of dough. Three, and occasionally four bakes are obtained per one firing. That is, bakes are done at different temperatures: First bake, 25 minutes; second, 45 minutes; third, 60 minutes; and fourth, 75 minutes. A typical formulation is 150 lb. flour,

3 lb. salt, 2 lb. fat, 4oz yeast (for 6-hour fermentation) or 16 oz. yeast (2-hour fermentation) plus k bromate + trace unidentified. The yeast is 100 percent imported Australian or Dutch. A specific loaf volume as low as 2.62 is acceptable though 3.0 is normal in practice. All socio-economic classes eat bread and flour where flour is consumed. Infants begin to eat bread at six months.

Fortificant(s) Situation

Vitamin and Mineral premixes are obtainable in Colombo through Unilever. Presumably, American premixes could be made available, if necessary.

Protein Sources to Fortify Wheat Flour

The suggestion of WPC derived from wheat milling byproducts produced objections on color, and exports/foreign exchange. The latter could probably be debated to our advantage.

Rice Bran is widely available but is produced at over 1,000 locations. The bran, currently traded from one government organization to another, at 560 rupees/L.T., No. 1 grade, and 360 rupees/L.T. second grade, is attractively priced as an economic fortificant. Ideally, for a food ingredient, rice bran should be stabilized. This is not currently practiced in Sri Lanka, though during 1977 plans are afoot to do so. At this stage, rice bran, or higher protein meals derivable from rice bran, should not be considered as a fortificant. Nevertheless, the Paddy Marketing Board, and the Medical Research Institute were keenly interested in this concept, and solicited WRRC's assistance in these endeavors.

The recovery of protein from coconut wastes was judged by the Medical Research Institute to be uneconomic and not technologically viable for Sri Lanka. The entire supply is used as a feed.

Soy

INTSOY has a strong program in Sri Lanka under the direction of Dr. Carl Hittle. INTSOY coordinates with the SL Soybean Development Program (Director, E. Herath), and the Agricultural Extension Service (Officer for Pulses (including soy), and Assistant Director, W.B. Medagama).

Collectively, these individuals are responsible for getting soy into Sri Lanka. They state the problem is simple: With the exception of CARE's need for soy (Brady cooker), markets for soy are almost non-existent and thus, farmers will not grow it - since production is extremely limited, it is impossible to build up a supply to guarantee a market. The Department of Agriculture is helping to solve this problem by providing free seed and inoculum and extension help, and by buying the production at 3.74-4 rupees/lb. (U.S. $0.53/lb.) for CARE and future seed. This price is inflated, but is believed necessary to stimulate production. Thereafter, the price is expected to decrease to a realistic level (circa 2 rupees/lb. or $0.27/lb.), since the yield of soy is double other legumes.

These gentlemen believe use of full-fat soy flour in bread at 5-10 percent level would be the perfect complement to their project. If added at 5 percent to locally milled wheat, need would be 5,000 T. of soy flour. Realistically, this would need ~10,000 acres. Maximum acreage 1975 = 3-3,500 acres; 1976 = 2,000 acres (400 T. soy flour equivalent). They believed in 2-3 years, they could meet the soy requirement.

Funding by UNICEF/UNDP and CARE for the INTSOY/SL Soybean Development Program has recently been approved. Each are contributing $227,000 over a 3-year period. This includes $277,500 for pilot-plant processing facilities. Included will be equipment to prepare full-fat soy flour, defatted soy flour, and soy protein concentrates and isolates.

A letter from Hittle, dated May 17, 1977, states "Sooner or later, one way or the other, I'm sure SL will be fortifying wheat flour with soybean flour. Thus, we all need all the assistance available."

Very near to the INTSOY headquarters is the Brady cooker. This equipment conceivably could be utilized in formulating a soy ingredient for bread fortification.

Government Support

The GOSL has a Food and Nutrition Policy Planning Committee. This committee serves as the Secretariat to the National Nutrition Committee which consists of secretaries from the following Ministries: Food and Cooperatives, Trade and Finance; Agricultural Lands; Education; Health; Planning and Economic Affairs. The Acting Director is Dr. Leslie Herath, who is also the Deputy Director, Ministry of Agriculture and Lands, and Chairman, National Livestock Development Board. This group would review any WRRC proposal and present to appropriate governmental ministeries for approval. Herath endorsed the vitamin and mineral package, and stated they have high hopes for the soybean. He believed the government would pay for the vitamin/mineral package. [WRRC stated that a study by the World Bank into flour enrichment with vitamins and minerals in Yemen, had forecast a cost of 1 percent of the flour - to be confirmed.]

Drs. Mahendra, Perera and DeMel of the Medical Research Institute, and Mr. Dissanayake, Secretary, Ministry of Food and Cooperatives, and Dr. Pulendiran, Deputy Food Commissioner, endorsed the vitamin and minerals enrichment, and believed the government would pay for it.

The Ceylon Institute of Scientific and Industrial Research has carried out research into soy fortification of breads (with Tropical Products Institute, London) and has modest testing facilities. This laboratory could be depended

upon for moral.and technolgical support, though probably not political clout.

SL Liaison Body

Suggest E. Herath, Director, Soybean Development Program in cooperation with C. Hittle, INTSOY, and backing of L. Herath, Acting Director, Food and Nutrition Policy Planning Committee.

PROPOSAL FOR SRI LANKA

WRRC will propose to implement a project to be in three phases:

1. Vitamin (A, B_1, B_2, B_3) and mineral (Ca, Fe) enrichment of locally milled flour (which ones?). To commence January 1978.

2. Fortify locally milled flour with 5 percent full-fat soy flour. To commence July 1978.

   Soy to be imported (through Title II?) paid for by AID.

   This phase is a demonstration/acceptability phase. Need consumer acceptance study.

3. Fortify with local full-fat soy flour. To commence January 1979.

Timetable, Activities, etc., include:

A. Approval by TA/N - by July 1, 1977.

B. Set up meetings with key GOSL figures and INTSOY - by July 31, 1977.

   Present proposal to GOSL - August 1977.

   Acceptance. Questions - who would answer them: 1) Government paying 2) INTSOY

C. Supply equipment, materials and technical help for Phase 1.

D. GOSL to assume vitamin and mineral costs ~ March 1978.

E. Arrange Title II soy flour as soon as possible after TA/N approval. Import commencing July 1978. Supply technical assistance for Phase 2.

F. Throughout life of project, supply assistance to INTSOY to meet Phase 3 deadline.

G. Phase 3 operating.

H. Nutritional gain in protein, vitamins and minerals intake clearly determinable.

Project Conclusions

1. Satisfies project terms: Nutritional improvement of a wheat-based food, and reaches the target.

2. Stimulates soy production which directly reaches to the small farmer - a goal of foreign assistance programs.

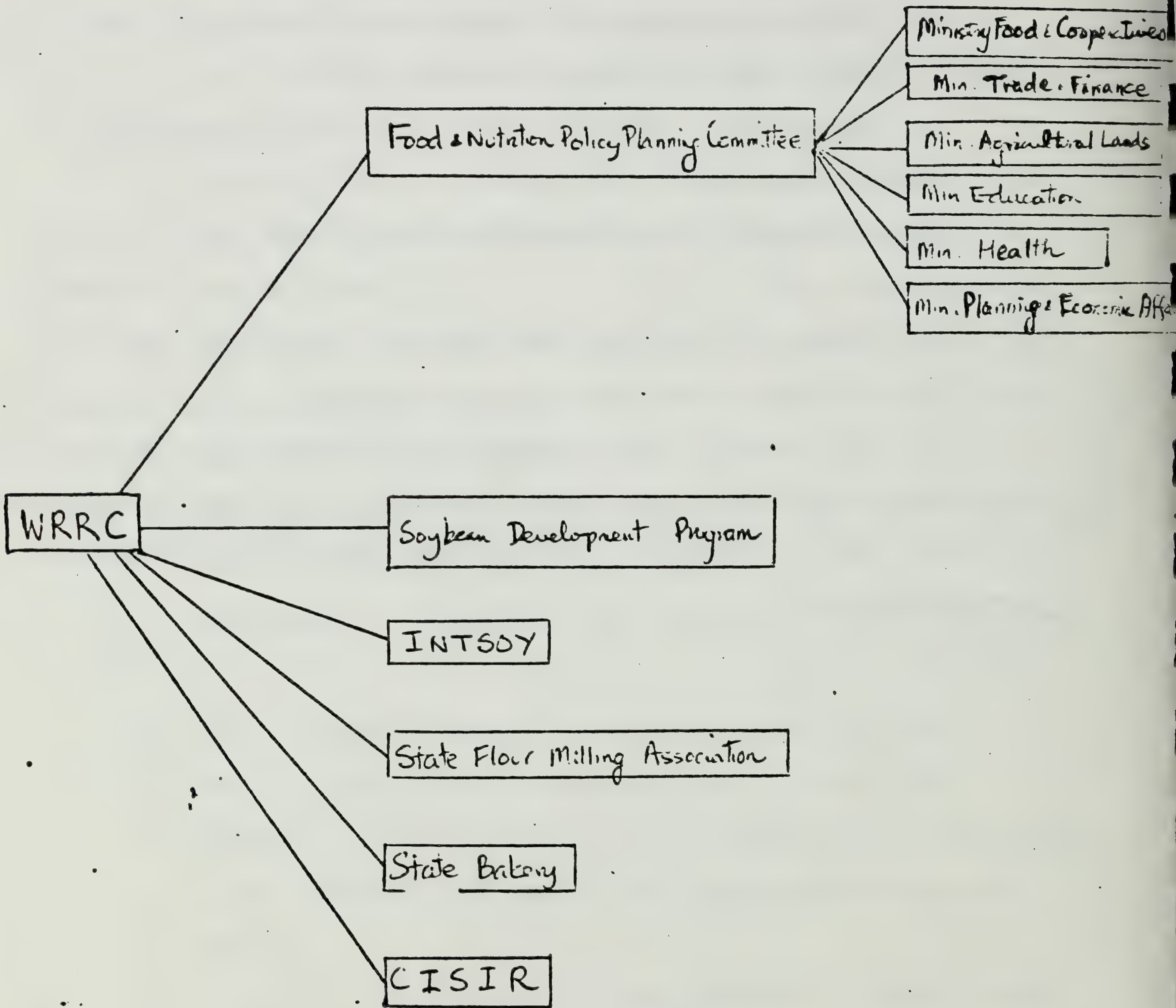
3. Improves GOSL's balance of payments position - requested by world monetary authorities.

4. Coordinates with UNICEF/UNDP/FAO funded INTSOY - good political consequences for AID.

5. Provides soy for Brady Cooker/CARE on a stable supply basis - vital for CARE's moves to have GOSL take over TURIPOSHA.

6. Strong moves by U.S.A. (Western Wheat Association) to get American wheat imported in place of poor quality Australian. Timeliness of getting soy into better quality flour, i.e., better volume/texture loaf could improve consumer acceptance.

Appendix E



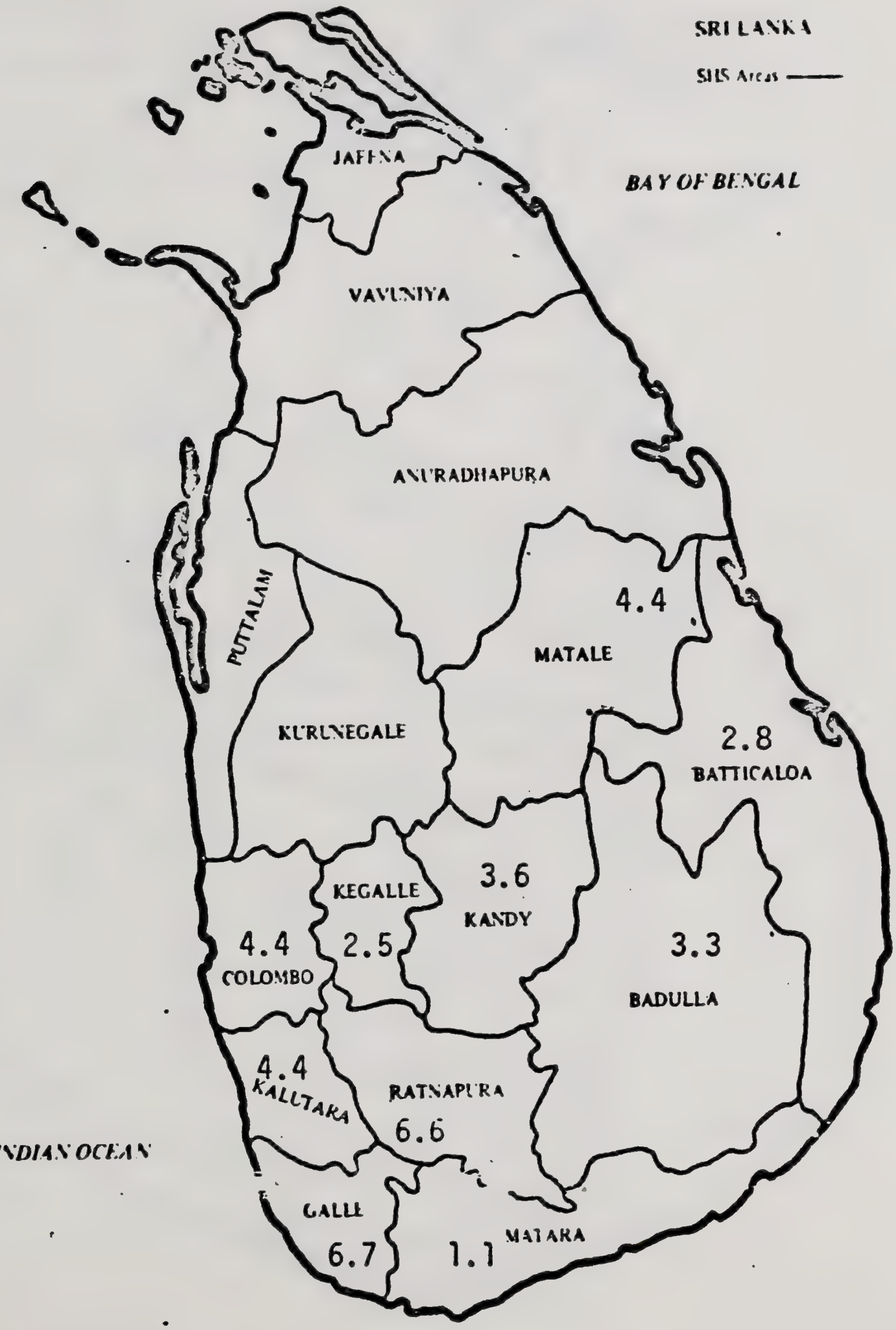
WRRC
Food & Nutrition Policy Planning Committee
Ministry Food & Cooperatives
Min. Trade & Finance
Min. Agricultural Lands
Min Education
Min. Health
Min. Planning & Economic Affa
Soybean Development Program
INTSOY
State Flour Milling Association
State Bakery
CISIR

Appendix E

ANEMIA

Percentage of children with anemia (Hemoglobin 10g/100ml 2yrs
CDC Survey 1976 or 11g/100ml 2yrs)

FIGURE 1

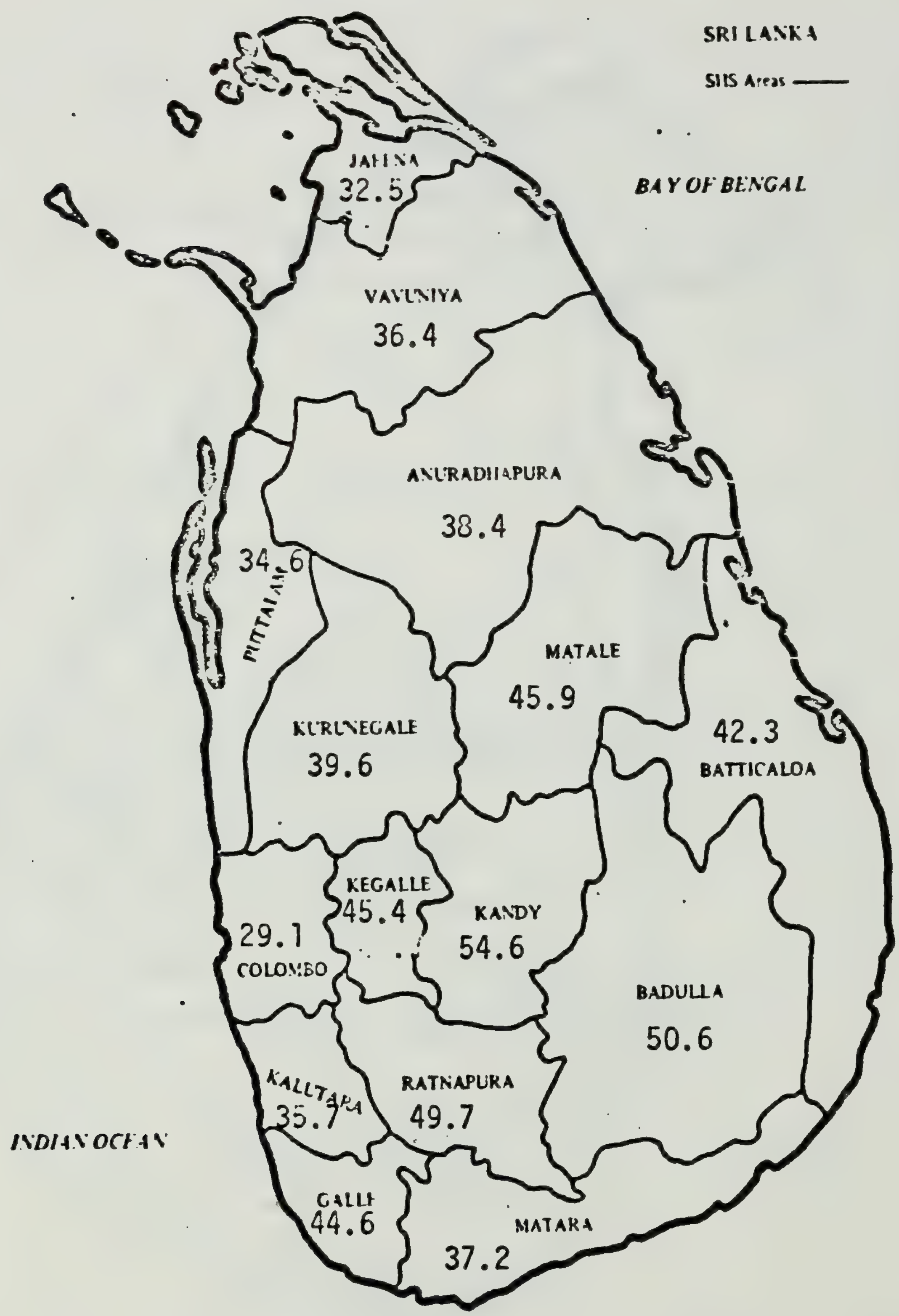


Weighted Average 3.8

MALNUTITION

Percentage of children with second and third degree malnutrition
CDC Survey 1976

FIGURE 1

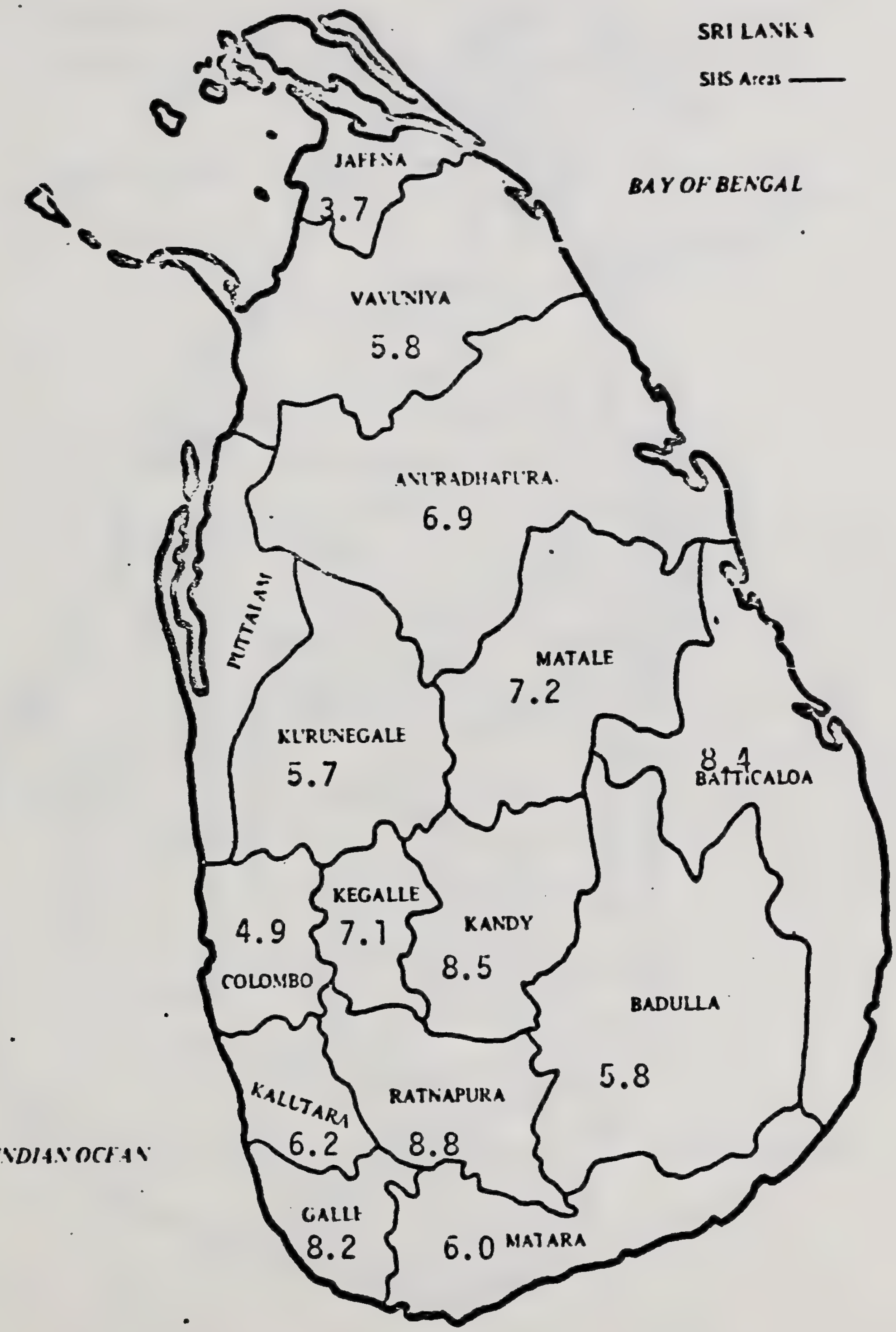


Weighted Average 42.0

MALNUTRITION

Percentage of children acutely undernourished ("wasting")
CDC Survey 1976

FIGURE 1



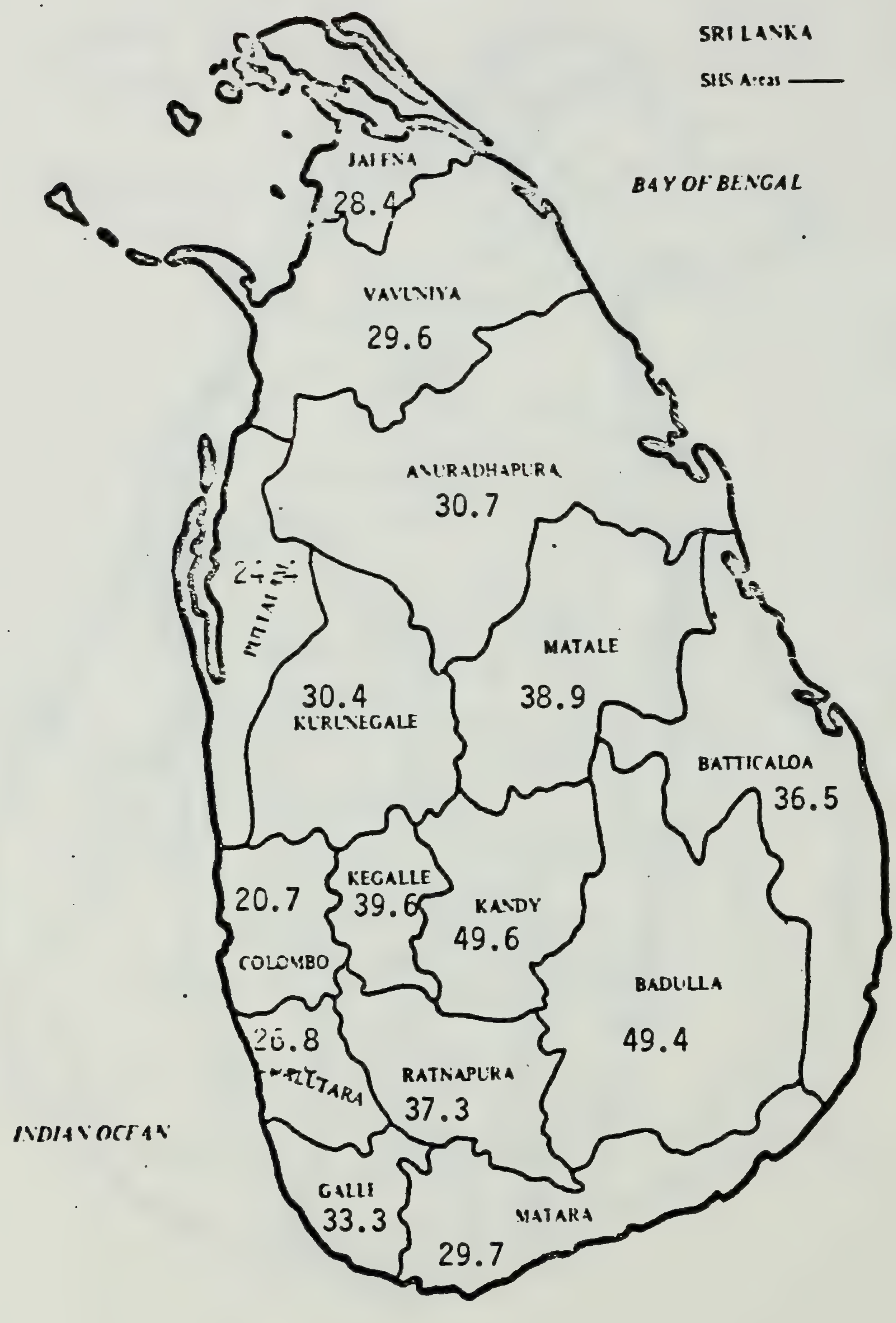
Weighted Average 6.6

Appendix E

MALNUTRITION

Percentage of children chronically undernourished ("stunting")
CDC Survey 1976

FIGURE I

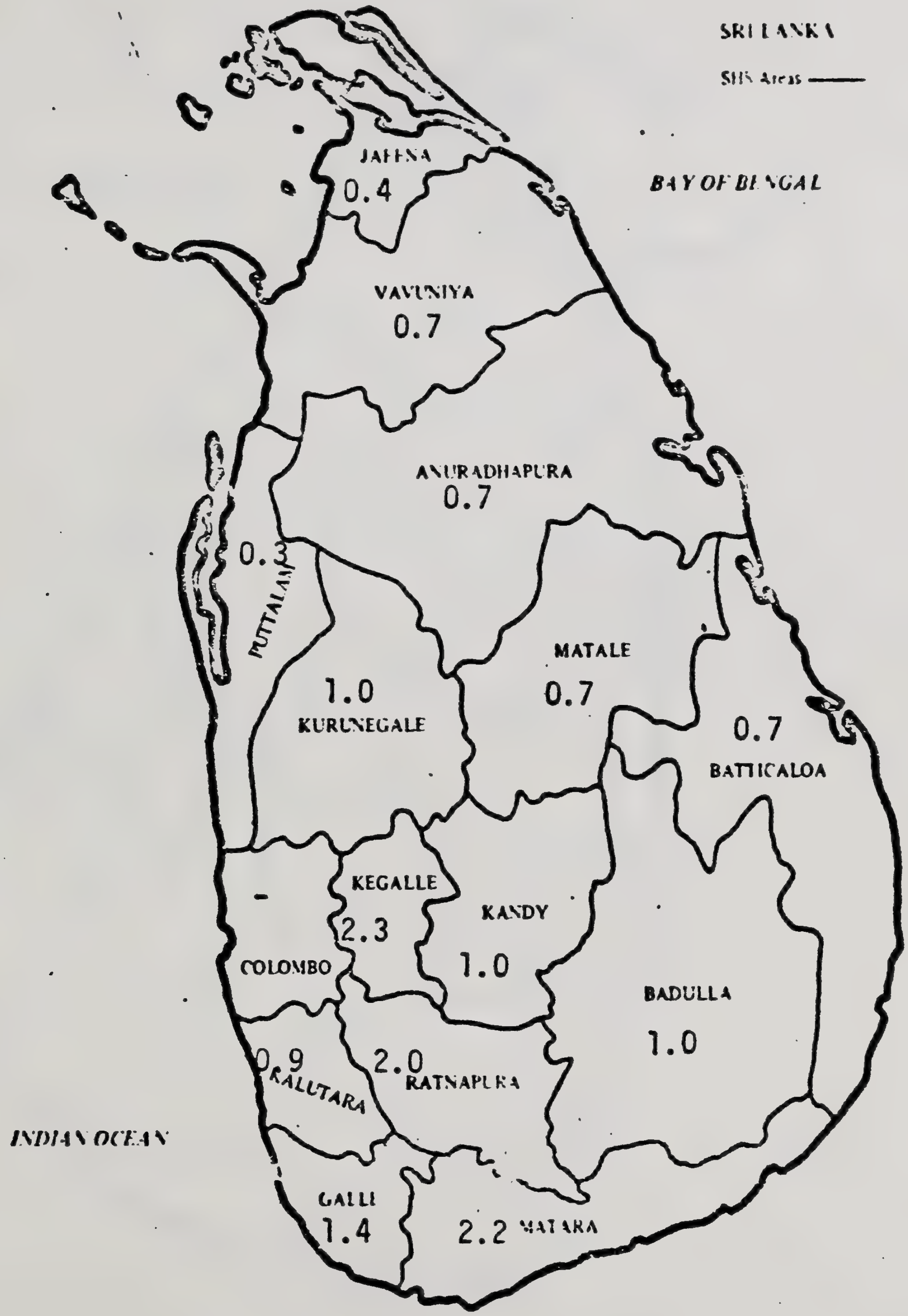


Weighted Average 34.7

VITAMIN A

Percentage of children with Bitotis Spots
CDC Survey 1976

FIGURE 1

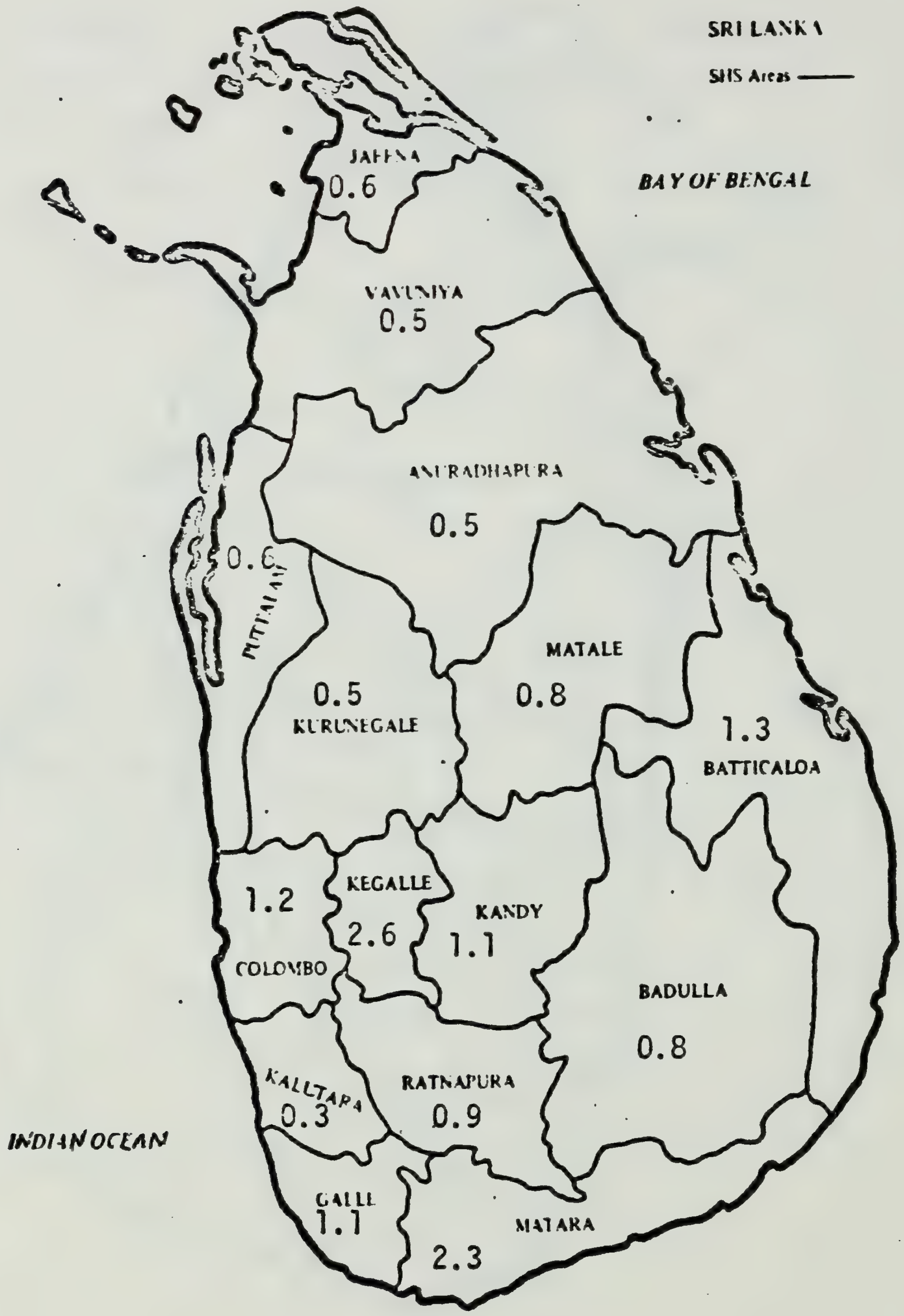


Weighted Average 1.1

VITAMIN A

Percentage of children with Night Blindness
CDC Survey 1976

FIGURE I



Weighted Average 1.0

Appendix B

FIGURE 8

Percentage of children with Night Blindness
LOS Survey 1976

Weighted Average 1.0